AD-A154 712 INSTALLATION RESTORATION PROGRAM PHASE I: RECORDS SEARCH MINOT AIR FORCE..(U) ENVIRONMENTAL SCIENCE AND ENGINEERING INC DENVER CO J B SOSEBEE ET AL. DEC 84 1/2

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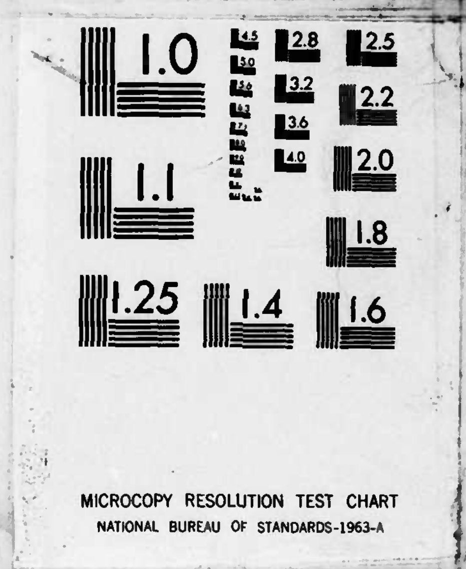
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AD-A154 712

INSTALLATION RESTORATION PROGRAM
PHASE I: RECORDS SEARCH

MINOT AIR FORCE BASE
NORTH DAKOTA

Prepared for:

UNITED STATES AIR FORCE
STRATEGIC AIR COMMAND
Deputy Chief of Staff
Engineering and Services
Offutt AFB, Nebraska 68113

Submitted by:

REYNOLDS, SMITH AND HILLS, INC.
Jacksonville, Florida

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
Englewood (Denver), Colorado

DECEMBER, 1984

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Records Search [redacted] Minot Air Force Base North Dakota

The search of USAF, state and federal agency records and interviews with past and present base personnel and agency representatives was conducted to identify past hazardous waste generation and disposal practices at Minot AFB, North Dakota. The AFB is located 14 miles notrh of the city of Minot in Ward County, North Dakota. Four off-base sites were also reviewed which include a recreation area, two radar sites and the base regional hospital located in Minot. Three activities were identified as potential hazardous waste generators. Petroteum storage, waste disposal and spills account for the most frequent and severe problems. Follow-on recommendations included site clean-up and closure, confirmation studies in the vicinity of past spill sites, and enhanced protection of local surface water

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(402) 294-5854

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EXECUTIVE SUMMARY

The Department of Defense (DOD) has developed the Installation Restoration Program (IRP) to identify and evaluate past hazardous material disposal sites on DOD property, control the migration of hazardous contaminants, and control hazards to health or human welfare that may result from these past disposal operations. The IRP has four phases consisting of Phase I, Initial Assessment/Records Search; Phase II, Confirmation and Quantification; Phase III, Technology Base Development/Evaluation of Remedial Action Alternatives; and Phase IV, Operations/Remedial Actions. The IRP will be the basis for response actions of Air Force Installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, Executive Order 12316, and 40 CFR 300 Subpart F (National Oil and Hazardous Substances Contingency Plan). CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites. Environmental Science and Engineering, Inc. was retained by the United States Air Force (USAF) to conduct the Phase I, Initial Assessment/Records Search for Minot Air Force Base (MAFB) and its subinstallations under Contract No. F08637-83-G0010-5008.

INSTALLATION DESCRIPTION

MAFB is located approximately 14 miles north of the city of Minot in Ward County, North Dakota. The base accommodates two strategic combat wings, an air defense squadron, and a number of smaller detachments on its 5,050 acres. A number of subinstallations are associated with the base. One hundred and fifty missile launch facilities and 15 launch control facilities are distributed within a 75 mile radius of MAFB. The Fortuna Air Force Station (AFS) Radar Site, Bismark Radar Bomb Scoring Site, USAF Regional Hospital in Minot, and Riverdale Recreation Area are under the jurisdiction of MAFB.

MAFB, constructed during the mid 1950s, is one of the newer bases in the USAF. The base is currently the home of the 57th Air Division, 91st Strategic Missile Wing (SMW), 5th Bombardment Wing (BMW), 91st Combat Support Group, USAF Regional Hospital, and several tenant units.

The primary mission of the host unit, the 91st SMW, is to maintain the operational capability to permit the conduct of strategic missile warfare according to emergency war orders. The 5th BMW is the major tenant unit at MAFB and has the mission of maintaining the capability of effectively conducting intermediate and long range strategic bombardment operations and providing conventional bombing capabilities as part of the Strategic Project Force. The 91st Combat Support Group provides essential support to the two major wings assigned to MAFB.

ENVIRONMENTAL SETTING

The environmental data reviewed for this investigation indicate the following major points that are relevant to the evaluation of past hazardous waste management practices at MAFB and its subinstallations:

- The MAFB region has a subhumid to semiarid climate typical of the Northern Great Plains. The average January temperature is 6.6 °F, but range as low as -60 °F. Mean monthly precipitation ranges from 0.37-inches (in) in January to 3.11-in in June.
- MAFB is located in the western part of the Drift Prairie Plain of the Central Lowland physiographic province. Local relief is about 50 feet (ft) and the approximate average elevation is 1,630 ft above mean sea level.
- Surface drainage from MAFB is into Egg Creek and then to the Souris River.
- The most widespread surficial deposits on the base is ground moraine consisting of clay, silt, sand, and larger fragments.
- Soils on the base consist primarily of silty loams derived from glacial till.
- All ground water of significance within the region is derived from precipitation. Most wells in the Minot area produce water from the glacial material.
- Egg Creek receives most of the drainage from MAFB and its sewage lagoons. It is designated as a Class III stream by the North Dakota State Department of Health, suitable for industrial and agricultural uses.

- No threatened or endangered species regularly inhabit either MAFB or any of its associated subinstallations.

METHODOLOGY

The objective of Phase I was to identify the potential for environmental contamination resulting from past waste disposal practices at MAFB and its subinstallations and to assess the potential for contaminant migration. Activities performed in the Phase I study included review of site records; interviews with personnel familiar with past generation and disposal activities; determination of quantities and locations of current and past hazardous waste treatment, storage, and disposal; performance of field inspections; and development of conclusions and recommendations.

FINDINGS AND CONCLUSIONS

The major industrial operations at MAFB and its subinstallations relate to the maintenance of aircraft, missiles, ground vehicles, and support facilities for the 91st SMW, 5th BMW, and the 91st Combat Support Group. Operations include engine repairs/overhauls; electrical, hydraulic, and fuel system repairs; painting; metal plating/finishing; missile system maintenance; aircraft maintenance; fuel supply and handling; and additional activities. Only limited activities are conducted at subinstallations.

The main types of waste generated at MAFB are fuels, oils and solvents, paints and paint strippers, metal plating/treatment solutions, and small amounts of explosives and pesticides. Waste fuel, oil, and solvents including JP-4, engine oil, PD680, and acetone which are derived primarily from periodic maintenance and engine repair. The general trend in waste disposal since the establishment of the base has been from largely unsegregated disposal in base landfills toward extensive waste segregation and contract disposal.

The review of past operation and maintenance functions and waste management practices at MAFB and its subinstallations identified nine potential areas of contamination. These sites were further evaluated using the decision process embodied in the IRP Record Search Format. This investigation

identified three areas on MAFB subject to contamination and potential contaminant migration as a result of past waste disposal practices (Figure ES-1). Each of these areas was evaluated using the Hazard Assessment Rating Methodology (HARM) system. The HARM scores for these three sites are presented in Table ES-1.

Area 1 -- Landfill

The base landfill has been used for disposal of domestic and miscellaneous industrial waste intermittently in the past. Leachate percolating from the base landfill contains metal and phenols which may have originated from garbage and/or hazardous waste placed in the landfill. Two pits within the landfill were used from 1977 to 1980 for the disposal of tank sludge. A nonconforming hazardous waste storage area within the landfill was used for hazardous waste storage from 1980 to 1982. There is evidence of some leakage from containers of hazardous materials placed in this enclosure.

Area 2 -- Firefighter Training Area

The Fire Protection Branch Training area served as a contaminated fuel and lubricant disposal area for many years. The old burn pit was equipped with a drain which directed liquids from the pit into a nearby drainage ditch.

Area 3 -- Explosive Ordnance Disposal (EOD) Range

The range is used to burn and explode unservicible munitions, starter cartridges, and and other small devices. Pits within the area are used to bury used starter cartridges. Metals from these materials could produce contamination within the area.

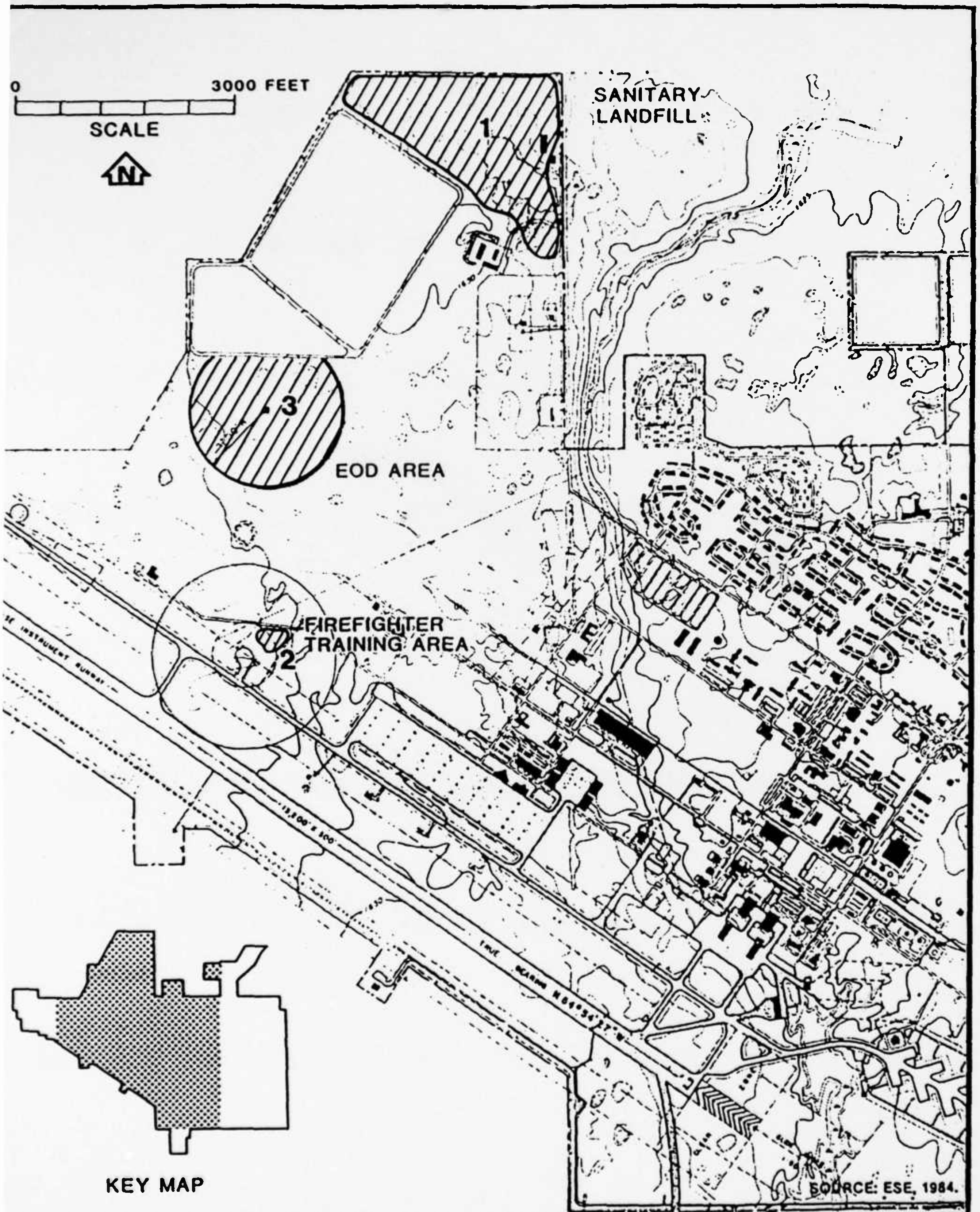


Figure ES-1
AREAS OF POTENTIAL
CONTAMINATION

INSTALLATION
RESTORATION PROGRAM
Minot Air Force Base

Table ES-1. Summary of HARM Scores

Rank	Site	Receptors Subscore	Waste Characteristics Subscore	Pathways Subscore	Waste Management Factor	Total Score
1.	Sanitary Landfill	45	48	100	0.95	61
2.	Firefighter Training Area	42	48	58	0.95	47
3	EOD Area	42	15	58	1.0	38

1.0 INTRODUCTION

This document presents the results of Phase I of the U.S. Air Force's (USAF) Installation and Restoration Program (IRP) for Minot Air Force Base (MAFB) near Minot, North Dakota. Abbreviations, acronyms, and technical terminology contained herein are explained in Appendix A.

1.1 BACKGROUND

Due to its primary mission, the USAF has long been engaged in operations dealing with toxic and hazardous materials. Federal, state, and local governments have developed strict regulations to require that disposers identify the locations and contents of disposal sites and take action to eliminate the hazards in an environmentally responsible manner. The primary Federal legislation governing disposal of hazardous waste is the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. Under Sec. 6003 of the Act, Federal Agencies are directed to assist the U.S. Environmental Protection Agency (EPA) and under Sec. 3012, state agencies are required to inventory past disposal sites and make the information available to the requesting agencies. To assure compliance with these hazardous waste regulations, the Department of Defense (DOD) developed the IRP. The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5, dated December 11, 1981, and implemented by USAF message, dated January 21, 1982. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the IRP. DOD policy is to identify and fully evaluate suspected problems associated with past hazardous contamination and to control hazards to health and welfare that resulted from these past operations. The IRP will be the basis for response action on USAF installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as clarified by Executive Order 12316, and 40 CFR 300 Subpart F (National Oil and Hazardous Substances Contingency Plan). CERCLA is the primary legislation governing remedial action at past hazardous waste disposal sites.

1.2 PURPOSE, AUTHORITY, AND SCOPE OF THE ASSESSMENT

The IRP has been developed as a four-phase program, as follows:

Phase I - Initial Assessment/Records Search

Phase II - Confirmation and Quantification

Phase III - Technology Base Development

Phase IV - Operations/Remedial Actions

Environmental Science and Engineering, Inc. (ESE) conducted the records search at MAFB and its subinstallations: Fortuna AFS Radar Site, Bismarck Radar Bomb Scoring Site, USAF Regional Hospital at Minot, and the Riverdale Recreation Area. Project funding was provided by the Strategic Air Command (SAC). This report contains a summary and evaluation of the information collected during Phase I of the IRP and recommendations for any necessary Phase II action.

The objective of Phase I was to identify the potential for environmental contamination from past waste disposal practices at MAFB and its subinstallations, and to assess the potential for contaminant migration. Activities performed in the Phase I study included the following:

1. Review of site records;
2. Interviews with personnel familiar with past generation and disposal activities;
3. Inventory of wastes;
4. Determination of estimated quantities and locations of current and past hazardous waste treatment, storage, and disposal;
5. Definition of the environmental setting at the base;
6. Review of past disposal practices and methods;
7. Performance of field and aerial inspections;
8. Gathering of pertinent information from federal, state, and local agencies;
9. Assessment of potential for contaminant migration; and
10. Development of conclusions and recommendations for follow-on action.

ESE performed the onsite portion of the records search during August 1984. The following team of professionals was involved:

- o Jackson B. Sosebee, Jr., Chemist/Geologist and Team Leader, 12 years of professional experience.
- o Douglas P. Reagan, Ph.D., Ecologist, 14 years of professional experience.
- o Douglas A. Dean, Environmental Engineer, 2 years of professional experience.

Detailed information on these individuals is presented in Appendix B.

1.3 METHODOLOGY

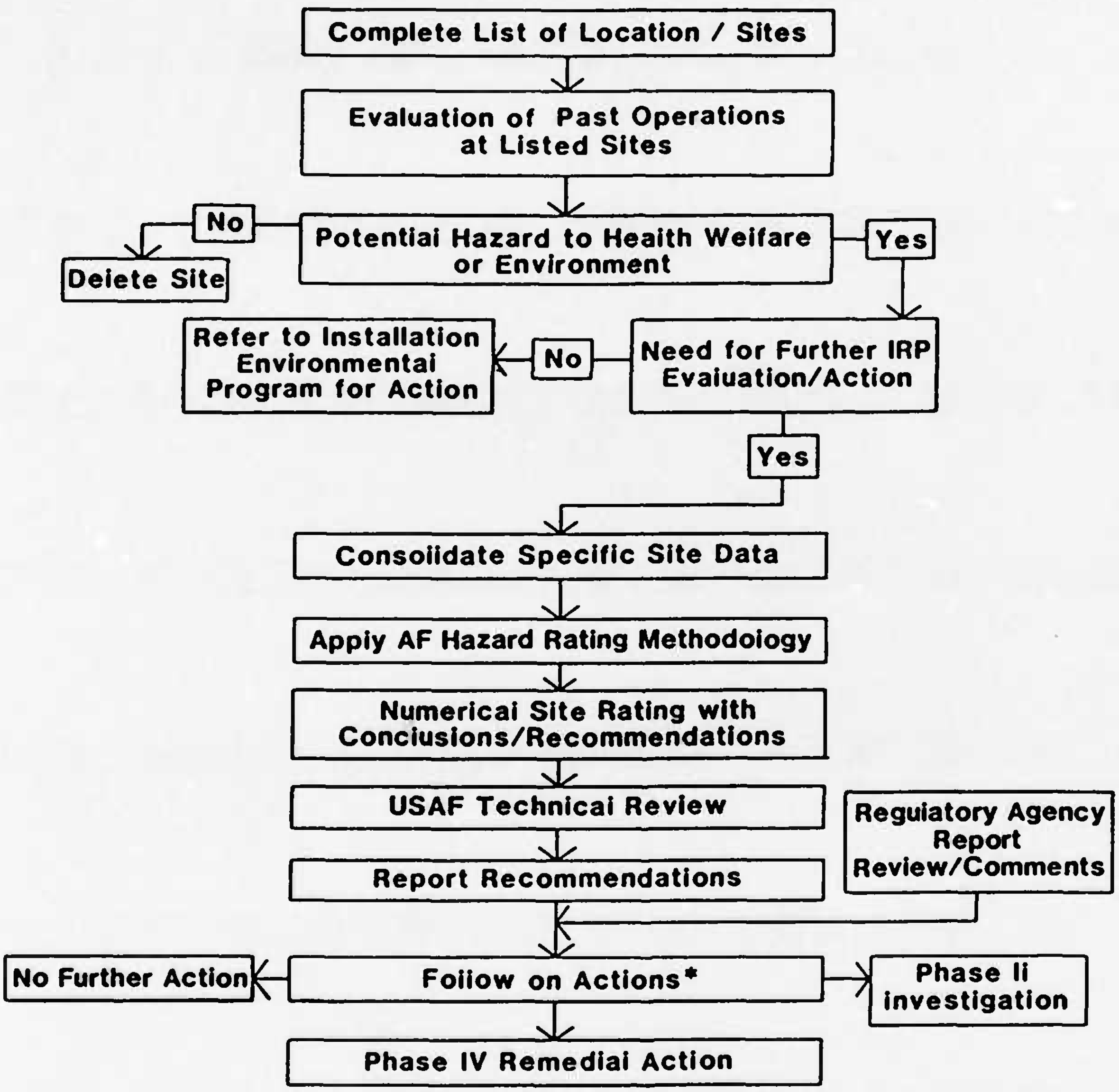
The methodology utilized in the MAFB records search began with a review of past and current industrial operations conducted at the base. Information was obtained from available records, such as shop files and real property files, as well as interviews with past and current base employees from the various operating areas. Interviewees included current and past Air Force personnel, Bioenvironmental Engineering Section (BES), tenant organizations on the base, and regional government agencies. A list of base interviewees by position and approximate years of service, and outside agency contacts is presented in Appendix C.

The next step in the activity review was to determine the past management practices regarding the use, storage, treatment, and disposal of hazardous materials from the various operations on the base. Included in this part of the activities review was the identification of all known past disposal sites and other possible sources of contamination, such as spill areas.

A ground tour of the identified sites were then made by the ESE Project Team to gather site-specific information including: (1) visual evidence of environmental stress; (2) the presence of nearby drainage ditches or surface water bodies; and (3) visual inspection of these water bodies for any obvious signs of contamination or leachate migration.

Using the process shown in Figure 1.3-1, a decision was then made, based on all of the above information, regarding the potential for hazardous material contamination at any of the identified sites. If no potential existed, the site was deleted from further consideration. If potential for contamination was identified, the potential for migration of the contamination was assessed based on site-specific conditions. If there were no further environmental concerns, the site was deleted. If the potential for contaminant migration existed, the site was evaluated and prioritized using the Hazard Assessment Rating Methodology (HARM). A discussion of the HARM system is presented in Appendix E. The sites, which were evaluated using the HARM procedures, were also reviewed with regard to future land use restrictions.

PHASE I INSTALLATION RESTORATION PROGRAM
RECORDS SEARCH FLOW CHART



*Beyond Scope of Phase I

SOURCE: AFESC, 1984

Figure 1.3-1 IRP RECORD SEARCH FORMAT	INSTALLATION RESTORATION PROGRAM Minot Air Force Base

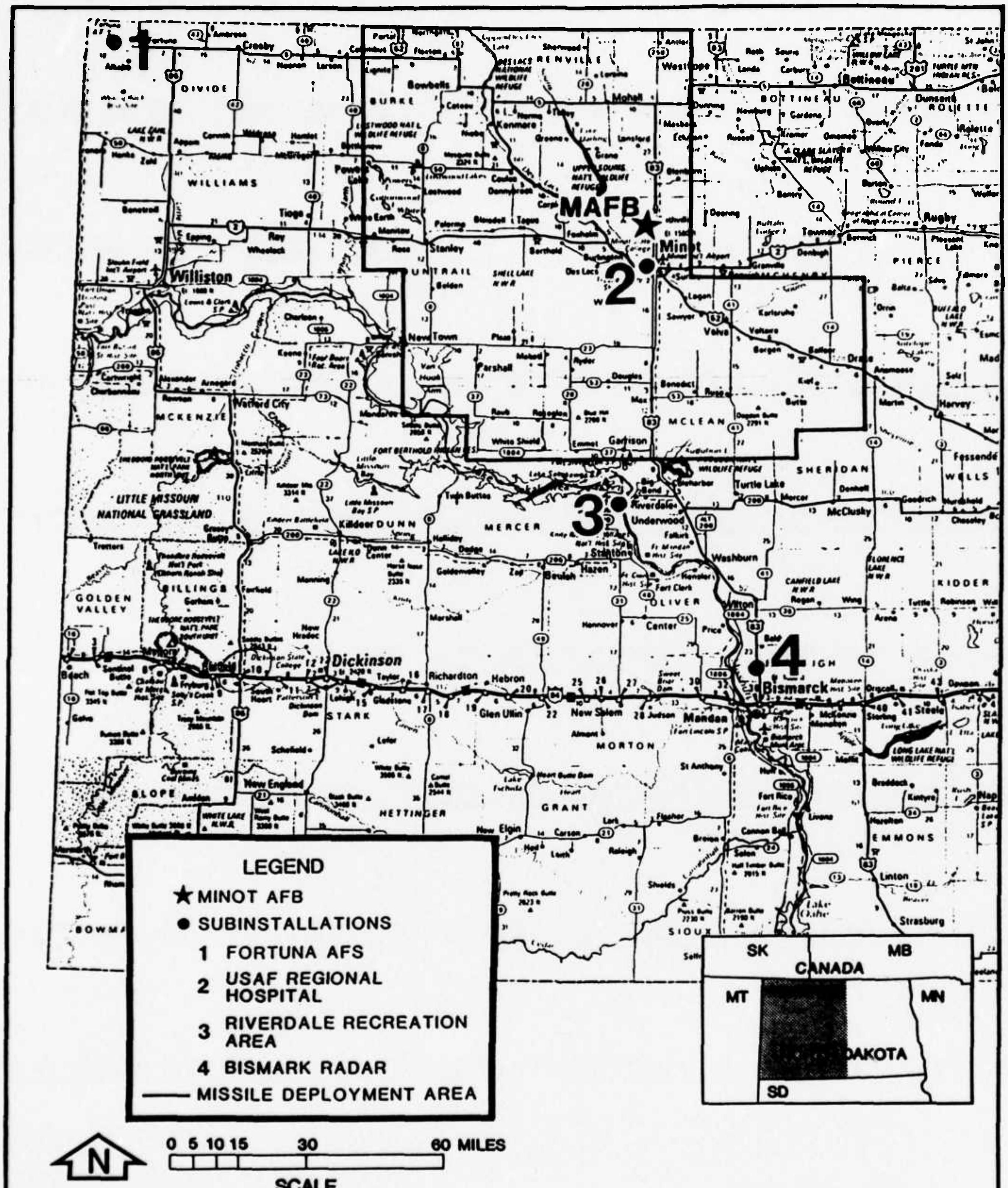
2.0 INSTALLATION DESCRIPTION

2.1 LOCATION/SIZE

MAFB is located approximately 14 miles north of the city of Minot in Ward County, North Dakota (Figure 2.1-1). The base proper occupies all or part of Sections 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, and 24 of T157N, R83W and Sections 7, 18, and 19 of T157N, R82W. The base accommodates two strategic combat wings, an air defense squadron, and a number of small detachments on its 5,050 acres. Runways, taxiways, aprons, and ammunition storage cover the southern and western portions of the base proper. The remaining area is comprised of maintenance shops, operations, housing, and recreations areas (Figure 2.1-2).

A number of subinstallations are associated with the base proper. One hundred and fifty missile launch facilities (LFs) and fifteen launch control facilities (LCFs) occupy a total of 321 acres distributed throughout the countryside north, west, and south of MAFB (Figure 2.1-3). The Fortuna Air Force Station (AFS) Radar Site (125 acres) is located 140 miles from the base proper in Divide County, North Dakota (Figure 2.1-4). Bismarck Radar Bomb Scoring Site (7 acres) is situated approximately 130 miles south of MAFB in Burleigh County, North Dakota. The USAF Regional Hospital (21 acres) in Minot (Figure 2.1-5) and Riverdale Recreation Area (6 acres) 60 miles south of MAFB on Lake Sakakawea are also associated with the base proper. Subinstallation locations are shown in Figure 2.1-1.

Outleases associated with MAFB include 56.04 acres to the Board of Education of the city of Minot, 5.26 acres to the Souris River Telephone Mutual Aid Corp., 228 acres to the Dufresne Riding Club, and 1.51 acres for the MAFB Credit Union. In 1980 hayland outleases on MAFB proper totaled 850 acres primarily for land adjacent to the main runway, SAC Alert Apron, and surrounding the Ammunition Storage Area. Contiguous leases and easements are located on farmland near the runway and adjacent to the sewage lagoons in the northwest portion of the base.



SOURCE: RAND McNALLY, 1981

Figure 2.1-1
LOCATION MAP -
MAFB AND SUBINSTALLATIONS

INSTALLATION
RESTORATION PROGRAM
Minot Air Force Base

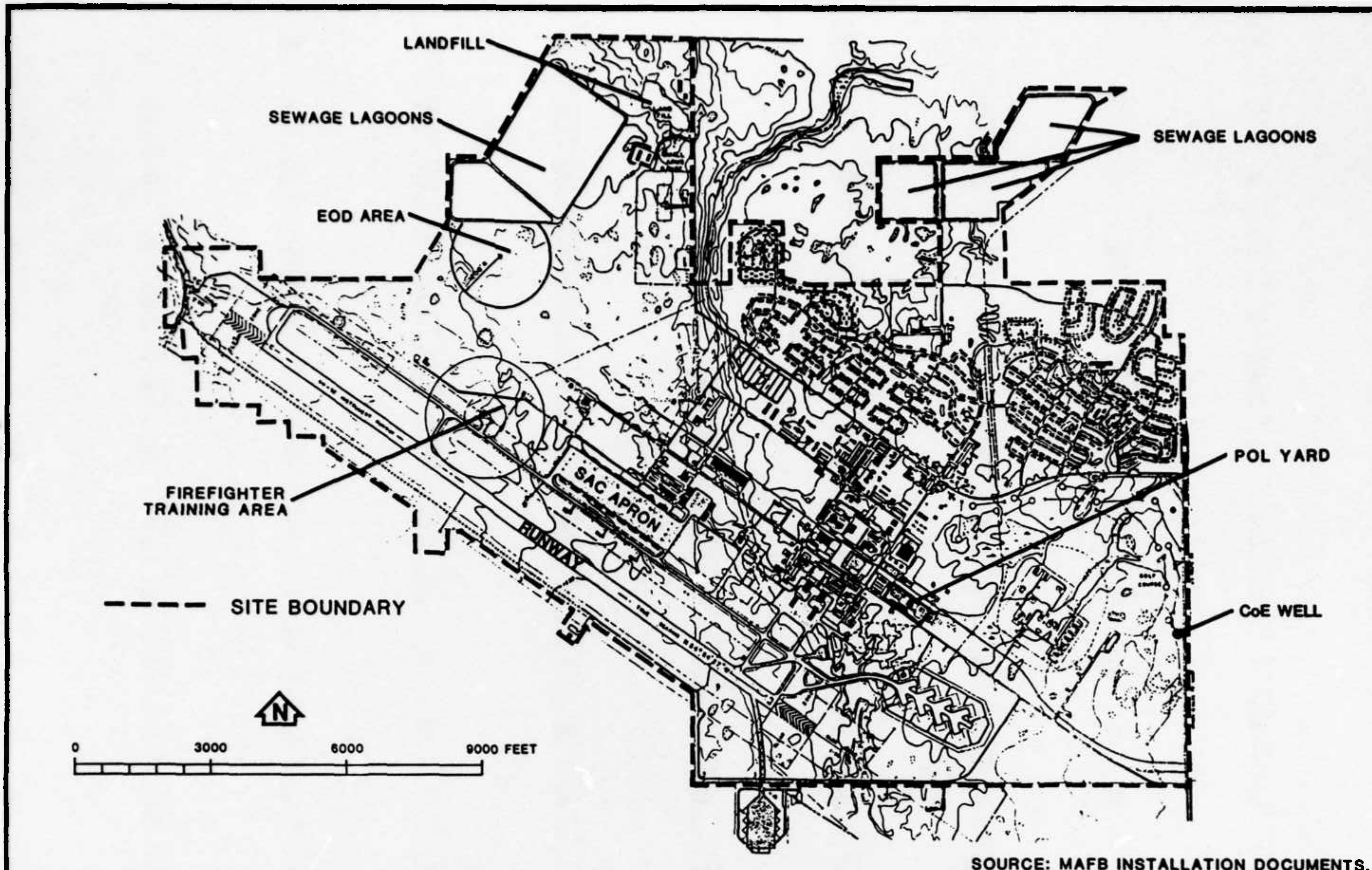


Figure 2.1-2
GENERAL BASE PLAN

INSTALLATION RESTORATION PROGRAM
Minot Air Force Base

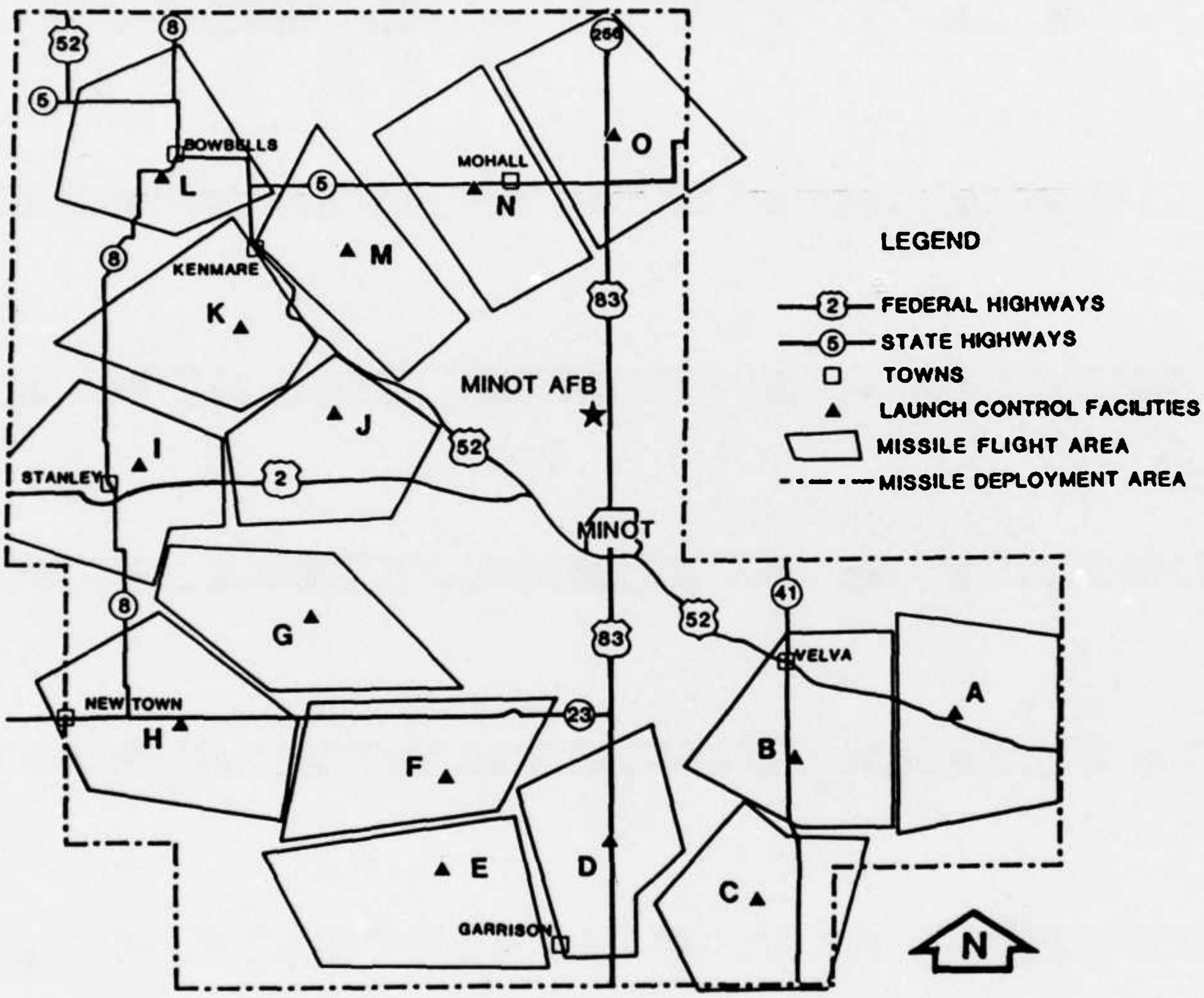


Figure 2.1-3
MISSILE DEPLOYMENT AREA

INSTALLATION RESTORATION PROGRAM
Minot Air Force Base

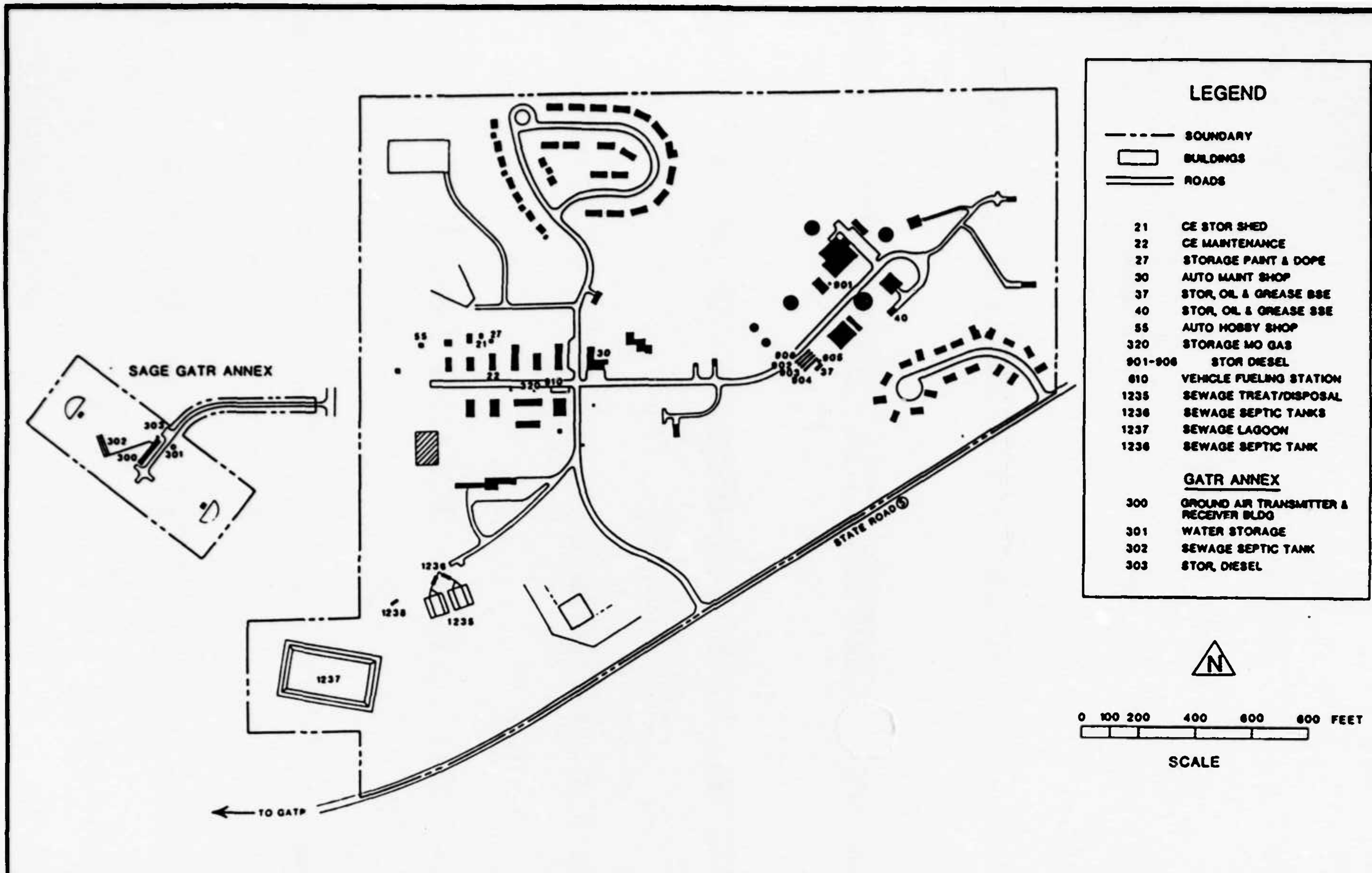
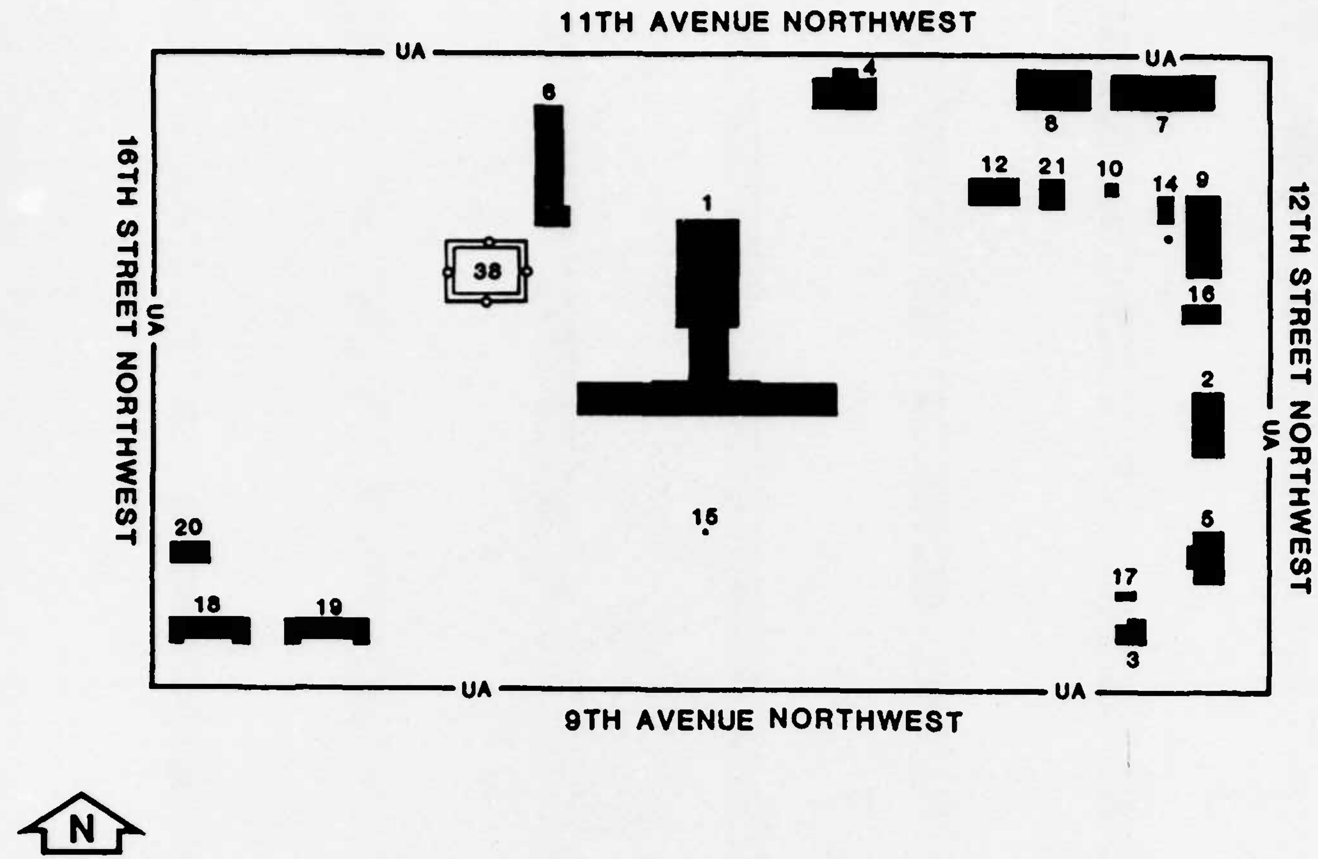


Figure 2.1-4
FORTUNA AFS

INSTALLATION
RESTORATION PROGRAM
Minot Air Force Base



SOURCE: MAFB INSTALLATION DOCUMENTS

Figure 2.1-5
USAF REGIONAL HOSPITAL

INSTALLATION RESTORATION PROGRAM
Minot Air Force Base

2.2 HISTORY

MAFB is one of the newer bases in the USAF. The first portions of land for the base were purchased in 1955, and the first buildings were constructed about two years later. The Aerospace Defense Command's (ADCOM) 32nd Fighter Wing was activated in February 1957, and the following year the SAC 4136th Strategic Wing, with KC-135 "Stratotankers," was assigned as a tenant unit. B-52 "Stratofortress" bombers were added to the SAC wing's inventory in 1961. Two years later, the 4136th was redesignated the 450th Bombardment Wing (BMW).

The first housing units opened in October 1960. Since then the MAFB housing area has become one of the largest in the Air Force with 2,470 family units.

The transfer of the base from ADCOM to SAC came in 1962 in conjunction with the arrival of the 810th Strategic Aerospace Division from Biggs Air Force Base (AFB), Texas. With the division came the activation of the 455th Strategic Missile Wing (SMW) and a Combat Support Group. By 1964, all 150 Minuteman intercontinental ballistic missile launch facilities were completed and the last of the Minuteman I missiles were emplaced.

In June 1968 the 455th SMW was redesignated the 91st SMW, and one month later, the 450th BMW became the 5th BMW. John Moses Hospital, located in downtown Minot and which the Air Force had taken over from the Veterans Administration in 1959, became a USAF Regional Hospital in July 1969.

In July 1971, the 91st SMW's 741st Strategic Missile Squadron became the first Minuteman III missile squadron in the Air Force. Six months later, the 810th Strategic Aerospace Division was deactivated and the 91st SMW became the senior unit on base. At this point, the 91st SMW was then assigned to the 4th Strategic Missile Division, Francis E. Warren AFB, Wyoming, and the 5th BMW became part of the 47th Air Division (AD), Fairchild AFB, Washington. In December 1971, the 91st SMW became the first fully-operational Minuteman III wing in the Air Force. The missile wing was realigned under the 47th AD in January 1973.

In Janaury 1975, the 57th AD was activated at MAFB, replacing the 47th AD at both MAFB and Grand Forks AFB. This move localized command along with insuring that assigned units would be capable of conducting aerial refueling, missile warfare and strategic reconnaissance according to the emergency war order. The 57th AD was later reorganized and augmented to fulfill Strategic Projection Force (SPF) responsibilities. On May 1, 1982, the 44th SMW and the 28th BMW at Ellsworth AFB, South Dakota were realigned to become members of the 57th AD. Also on May 1, Grand Forks AFB was assigned to the 4th AD at F.E. Warren AFB, Wyoming. The 55th Reconnaissance Wing, Offut AFB, Nebraska, 28th BMW, Ellsworth AFB and 5th BMW at MAFB combine to make up the SPF.

MAFB is presently the home of the 57th AD, 91st SMW, 5th BMW, 91st Combat Support Group, USAF Regional Hospital, 5th Fighter Interceptor Squadron, 2150th Communications Squadron, and several other tenant units.

2.3 ORGANIZATION AND MISSION

The 91st SMW is the host unit for MAFB. Major units falling under the wing are the 91st Combat Support Group; 91st Security Police Group; USAF Regional Hoapital in Minot; 740th, 741st, and 742nd Strategic Missile Squadrons; 91st Headquarters Squadron; 91st Organizational Missile Maintenance Squadron; 91st Field Missile Maintenance Squadron; 91st Transportation Squadron; 91st Supply Squadron; and 91st Services Squadron.

The primary mission of the 91st SMW is to maintain the operational capability to permit conduct of strategic missile warfare according to emergency war orders. To accomplish this, the wing's force of Minuteman missiles and combat crew members must be kept at a high state of readiness in order to react swiftly should the need arise.

One of the six Minuteman wings in SAC, the 91st SMW provides 150 Minuteman III missiles of SAC's total missile deterent of 1,000 Minuteman and 523 Titan II missiles. Two-man missile combat crews control the Minuteman missiles from 15 dispersed and hardened LCFs. Each LCF controls 10 dispersed Minuteman missiles.

The 91st Combat Support Group provides essential support to the two major wings assigned to MAFB, the 91st SMW and the 5th BMW. The group's mission is to provide the support and services necessary to maintain the combat readiness of the two wings.

2.4 MAJOR TENANTS

The 5th BMW is the major SAC tenant unit at MAFB. Operational control, command jurisdiction, and administrative responsibilities of the wing are exercised by the 57th Air Division, also located at MAFB. From there the chain of command leads to the 15th Air Force, headquartered at March AFB, California, and ultimately to SAC Headquarters at Offutt AFB, Nebraska.

The mission of the 5th BMW is to effectively conduct intermediate and long range strategic bombardment operations and to provide convention bombing capabilities as part of the the SPF with assigned B-52H Stratofortess aircraft. The wing additionally provides air refueling, and cargo and passenger transportation support with its fleet of KC-135A Stratotankers.

Other tenant units at MAFB include the 5th Fighter Interceptor Squadron; 2150 Communications Squadron; Detachment 7, 37th Aerospace Rescue and Recovery Squadron; Detachment 21, 9th Weather Squadron; Detachment 1312, Air Force Office of Special Investigation; Detachment 7, Air Force Institute of Technology; Detachment 520, Air Force Audit Agency; Air Training Command Field Traning Detachment 421; SAC Management Engineering Team; Detachment 5, Site Activation Task Force; Defense Investigation Service; Headquarters (HQ) USAF Area Defense Counsel; and 1st Combat Evaluation Group, Detachment 14.

3.0 ENVIRONMENTAL SETTING

3.1 METEOROLOGY

The MAFB region has a subhumid to semiarid climate typical of the Northern Great Plains. The average January temperature is 6.6 degrees Farenheit (°F) but minimum readings of -60°F have been recorded. The mean July temperature is 69°F with readings of 100°F or more occassionally recorded. For a 54 year recording period the average annual temperature for the Minot area (Pettyjohn & Hills, 1965) was 39.7°F.

The mean monthly precipitation ranges from a low of 0.37 inches (in) in January to a high of 3.11-in during June. About half of the annual precipitation commonly occurs from May through July. The average annual precipitation is about 15.5-in, but large variations in precipitation from year to year are normal. Summer days are usually hot, clear and dry during the afternoon. Short heavy thunderstorms and long droughts are also common and both are sometimes severe. Winters tend to be dry but rigorous. The frost depth averages about 4 feet (ft) with a maximum of 6½ ft. Prevailing winds are northwesterly throughout the year. Temperature and precipitation data for the area are summarized in Table 3.1-1.

3.2 GEOGRAPHY

3.2.1 PHYSIOGRAPHY

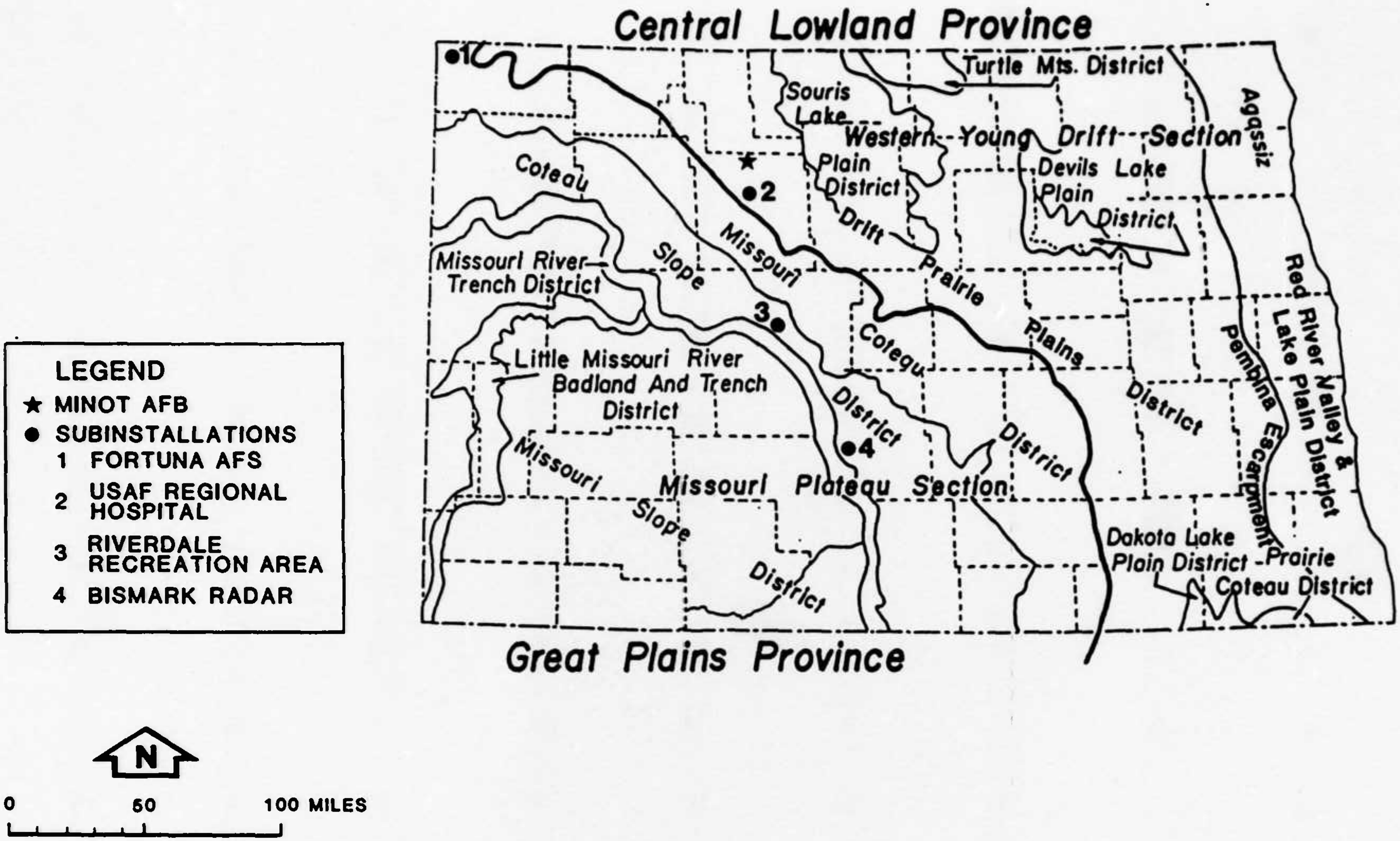
MAFB is located in the western part of the Drift Prairie Plain of the Central Lowland physiographic province (Figure 3.2-1) (Hansen and Kune, 1970). The Drift Prairie in this area is characterized by a northeastward-sloping, gently to moderately undulating plain with occassional sloughs of glacial origin. Local relief is about 50 ft and the approximate average elevation is 1,630 ft above sea level. A small escarpment about 15 miles southwest of MAFB forms the northeastern extent of the Missouri Coteau and the Great Plains district (Missouri Plateau section).

Shallow depressions with large boulders in the center are believed to have originated from buffalo (and later cattle) rubbing themselves on the boulders and disturbing the surrounding soil. Heavy winds would then erode the loose soil leaving large "buffalo boulders" exposed.

Table 3.1-1. Average Monthly Precipitation and Temperature at Minot, North Dakota for 54 Year Period

Month	Average Precipitation (Inches)	Average Temperature (°F)
January	0.37	6.6
February	0.43	10.2
March	0.61	23.6
April	1.22	40.8
May	2.16	53.1
June	3.11	65.1
July	2.05	68.8
August	1.92	65.6
September	1.60	56.4
October	0.91	43.8
November	0.66	27.4
December	0.46	13.1
Year	15.50	39.7

Source: Pettyjohn and Hills, 1965



SOURCE: HANSEN & KUME, 1970.

Figure 3.2-1
PHYSIOGRAPHIC UNITS OF NORTH DAKOTA

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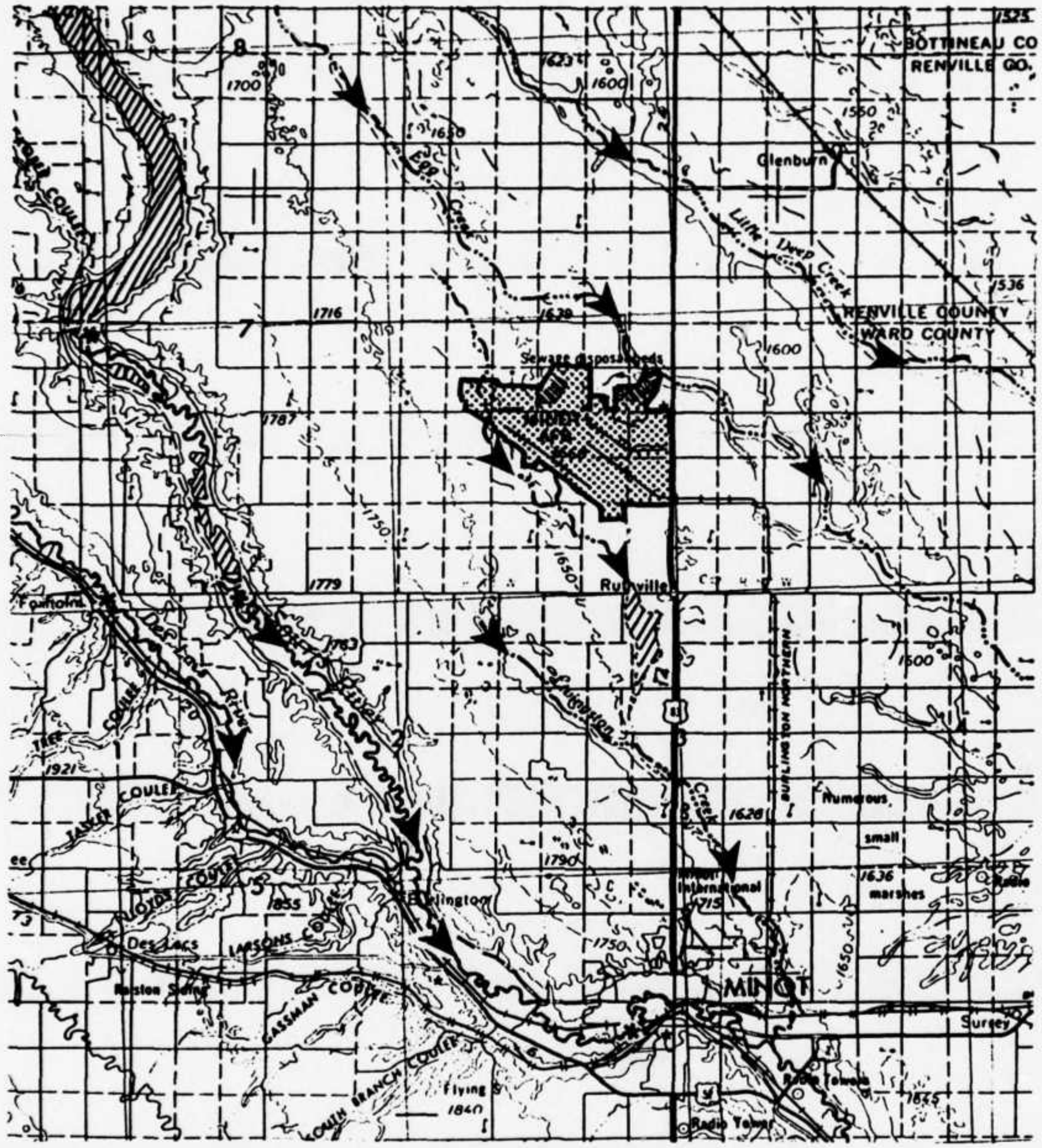
3.2.2 SURFACE WATER HYDROLOGY

The Souris and Des Lacs Rivers flow out of the north about 6 and 8 miles southwest of MAFB (Figure 3.2-2). They join and form the Souris River south of the base at Burlington. The rivers are wide and flat with several dams and reservoirs along their length. After leaving Ward County the Souris River flows back north into Canada and forms part of the drainage system for the Red River of the North. The Red River of the North Basin is part of the Hudson Bay Basin.

The Souris and Des Lacs rivers are the only perennial streams in Ward County. Intermittent streams in the vicinity of MAFB include Egg, Little Deep, and Livingston creeks. Permanent gaging stations are not installed on intermittent streams so flow data are only available for Souris and Des Lacs rivers.

The average discharge for the Souris River near Foxholm, North Dakota for the period of record is 148 cubic feet per second (cfs) and the average discharge for the Des Lacs River in the same area is about 32 cfs (USGS, 1979 and USGS, 1982). Peak flows are usually attained during April or May in response to the spring snowmelt and runoff. Minimum flows occur between October and February with no flow periods commonly recorded during very dry years. The Souris River stream gaging station below the confluence of the Souris and Des Lacs Rivers near Minot has recorded the average discharge to be 170 cfs with peak flows of 6,000 cfs in 1979 and 3,070 cfs in April 1982. The minimum flow for 1982 during the month of October was down to 1 cfs for the Souris River near Minot. Intermittent streams to the northeast and southwest of MAFB probably have flow patterns similar to the perennial streams discussed above.

Surface water drainage on MAFB is primarily a network of drainage ditches, pipes and lines that eventually discharge into two primary drainage ditches which flow north into Egg Creek (Figure 3.2-3). The western primary drainage ditch uses a glacial meltwater channel to direct surface water runoff into Egg Creek. A small portion of storm water runoff on the west end of the runway flows west to south flowing intermittent stream.



SCALE 1:250,000

N

LEGEND

- SURFACE WATER FLOW DIRECTION
- LAKE OR POND
- MINOT AIR FORCE BASE
- PERENNIAL STREAM
- INTERMITTENT STREAM
- STREAM GAGING STATION

SOURCE: USGS,1971.

Figure 3.2-2
STREAM DRAINAGE PATTERNS

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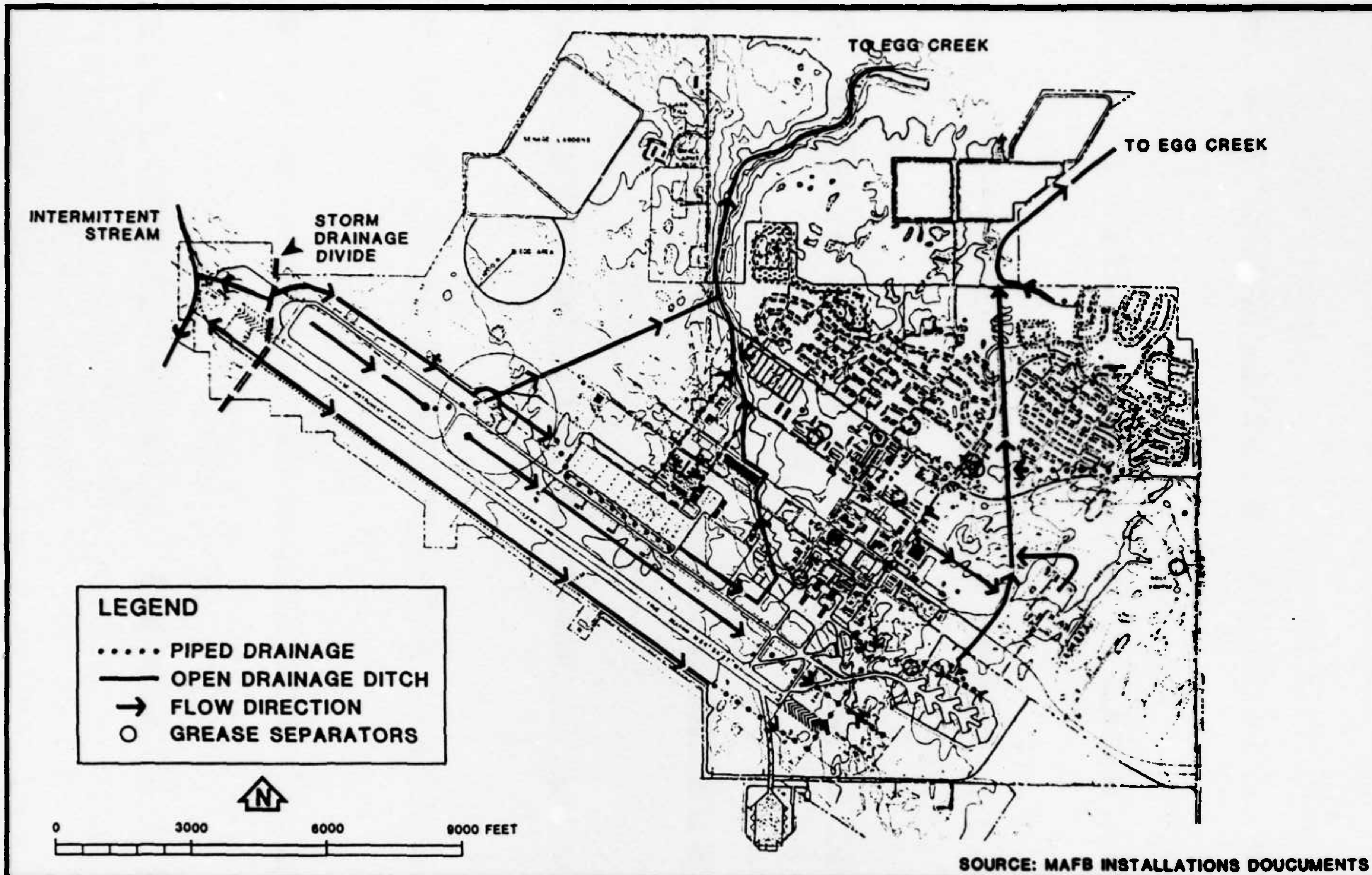

Figure 3.2-3
SURFACE WATER DRAINAGE AND PRIMARY STORM DRAINAGE SYSTEM

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3.3 GEOLOGY

3.3.1 GEOLOGIC SETTING

General Bedrock Geology

The western two-thirds of North Dakota contains rocks of the Williston Basin. MAFB is located on the east flank of the basin (Figure 3.3-1). The present shape of the Williston Basin was formed in Cretaceous time. The regional dip of the sediments in the study area is only about 60 ft in a mile or less than one degree (Bluemle, 1977). The bedrock surface below the base may be eroded to slope about 10 ft per mile to the northeast according to Lemke (1960).

Oil well tests in the area provide some information on the underlying Precambrian and Paleozoic rocks. The Precambrian basement is interpreted to be at a depth of over 8,000 ft (Lemke, 1960 and Froelich, 1964). The overlying Paleozoic rocks primarily consist of shale, limestone, sandstone, and some evaporites. They thin and pinch out to the east.

Triassic and Jurassic formations consist of shale, dolomite, limestone and sandstone. As with the Paleozoic sediments, the Mesozoic beds thin to the east and large unconformities, important in oil exploration, also exist.

Significant units of the Upper Cretaceous series (Table 3.3-1) include the Pierre, Fox Hills and the Hell Creek formations. The Pierre is a marine shale that is between 800 (eroded) and 1,200 ft thick. Overlying the Pierre is up to 250 ft of crossbedded sandstone and some shale of the Fox Hills Formation. Its lithology suggests a marine shallow water depositional history. A large inland sea was probably present in Late Cretaceous time and the Fox Hills sediments are probably remnants of near-shore or shoreline depositional features (Froelich, 1964).

The uppermost Cretaceous sediment is the Hell Creek Formation consisting of alternating beds of fine-grained sandstone, siltstone, shale, and lignite. It is about 205 ft thick in the Minot Area.

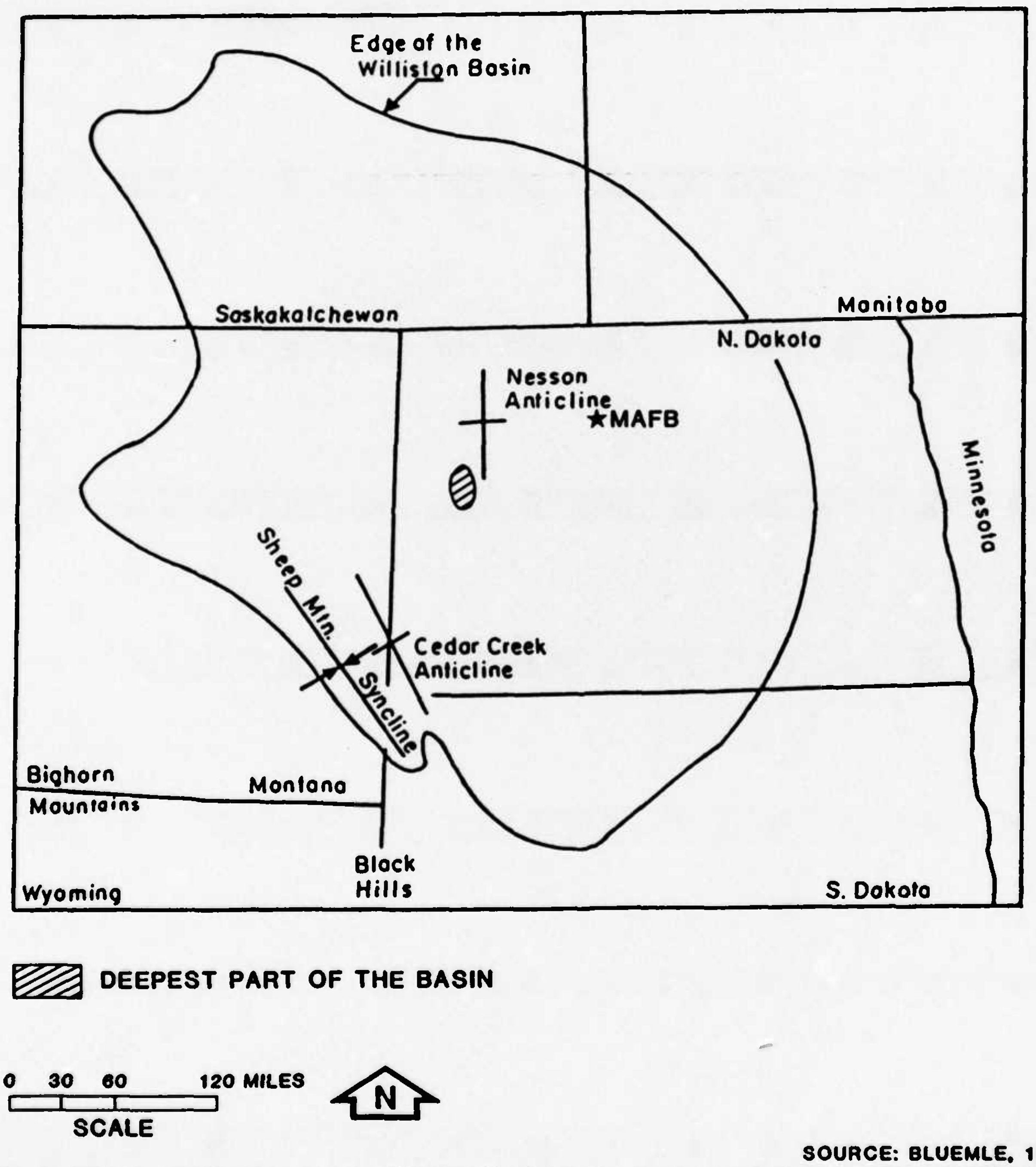

Figure 3.3-1
MAP OF THE WILLISTON BASIN

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Table 3.3-1. Upper Bedrock Geologic Units and Their Water-Yielding Properties

Era	System	Series	Geologic Unit	Physical Character	Water-Yielding Characteristics
Cenozoic	Tertiary	Paleocene	Fort Union Group	Sandstone, silt, shale, and lignite.	Generally of low permeability. Yields small quantities of water, generally adequate for domestic and stock use. Water may be saline and contain dissolved gas.
Mesozoic	Cretaceous	Upper Cretaceous	Hell Creek Formation	Mudstone, sandy shale, sandstone, and lignite.	Relatively impermeable. May yield very small quantities of water in the area.
			Fox Hills Formation	Sandstone and shale.	Permeable. Yield unknown.
			Pierre Formation	Consolidated bluish-gray to dark-gray marine shale, sandy in places, fossiliferous, contains many concretions in places.	Relatively impermeable, may yield very small quantities of water from sand lenses and fractures common in the upper part.
			Colorado Group	Consolidated dark-gray shale, dense, calcareous, and bentonitic; also limestone, which may include alternating layers of shale and sandstone.	Relatively impermeable. Not known to yield water in the area. Sandstone may yield limited supplies.
		Lower Cretaceous	Dakota Group	Sandstone, fine to coarse grained; consolidated, calcareous, and very bentonitic shale.	Permeable. Yields large quantites of saline water from depths of $\pm 2,500$ ft.

Source: Pettyjohn & Hutchinson, 1971.

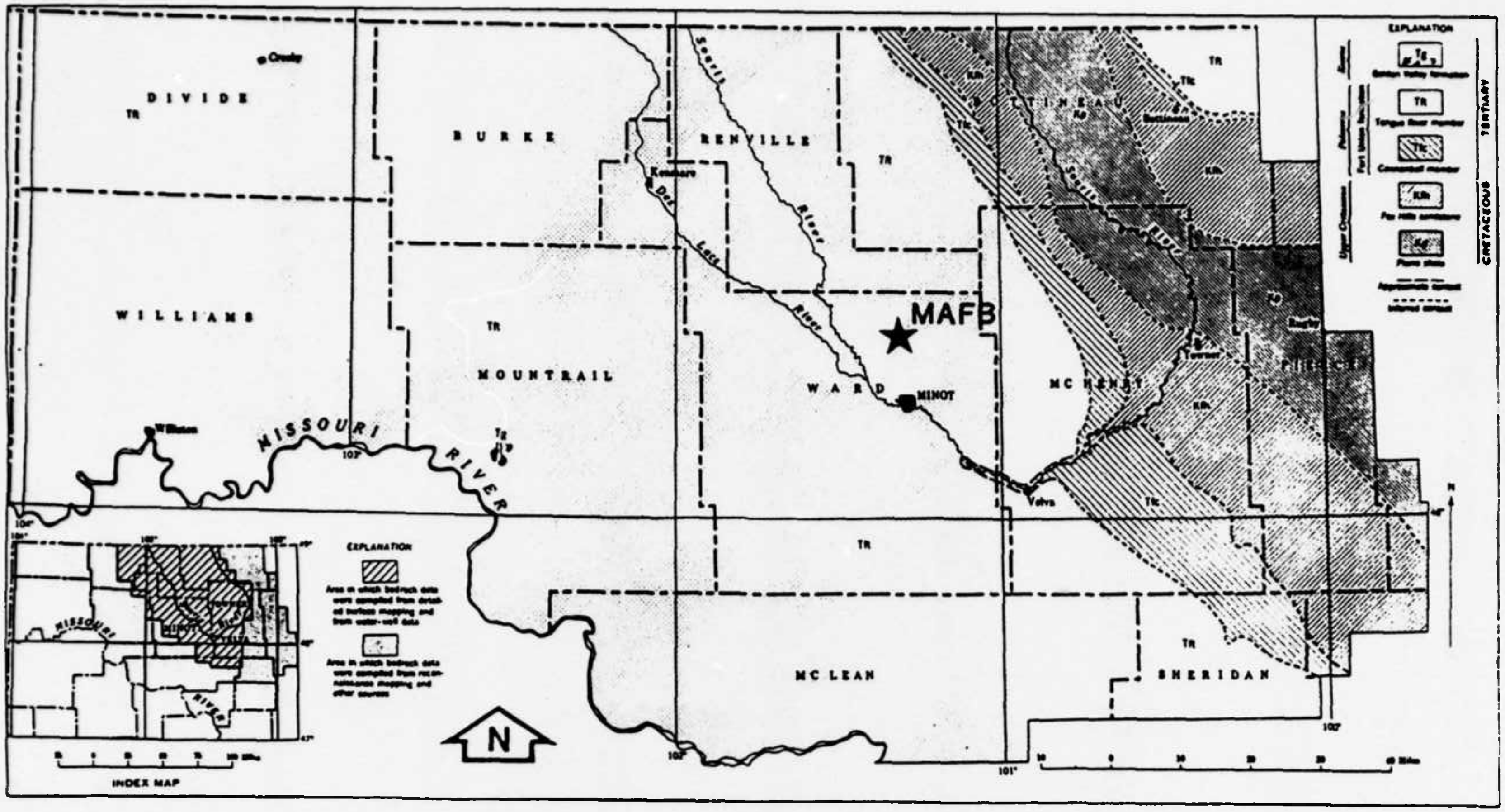
Tertiary rocks of the Paleocene series underlying MAFB belong to the Fort Union Group (Figure 3.3-2). The Tongue River (youngest) and the Cannonball members of the Fort Union are both believed to exist but their total thickness is unknown. The Cannonball member consists of thinly bedded sand silt and sandy shale. Carbonate-rich concretions are commonly found along bedding planes. The Tongue River member forms the bedrock topography about 200 ft below the present ground surface. It is composed of indurated and crossbedded sandstone, siltstone, silty fissile shale and clay. Less than five percent of the total lithology is lignite (Lemke, 1960). It is generally described as a nonmarine fluvial and lacustrine sediment deposited east of the developing Rocky Mountains during the Paleocene. Shifting of water bodies during accumulation caused the layers to be discontinuous and uneven in thickness. Later uplift resulted in erosion of the upper deposits prior to Pleistocene glaciation.

General Glacial Geology

Surficial glacial sediments throughout most of the area are from Late Wisconsin stage Pleistocene glaciations that occurred between 25,000 and 12,000 years before present (ybp) (Kehew, 1983). The detailed glacial history of the Minot area is complex. At MAFB, three units of Coleharbor Group and two units of Oahe Formation sediments have been identified by Kehew (1983) (Figure 3.3-3 and Table 3.3-2).

The most widespread surficial deposit of the base is ground moraine (or till of the Coleharbor Group) consisting of clay, silt, sand, and larger fragments in varying proportions. Ground moraine represents till that, deposited as sediment within and on the stagnating glacier, was deposited on base material as the ice melted. It is poorly sorted, non-bedded material with little vertical or horizontal homogeneity.

A separate unit of Coleharbor Group sediment has been identified in the extreme northeast portion of MAFB near Egg Creek. It is basically the same as the ground moraine in the area in lithologic composition but consists of glacial sediment eroded by rivers that flowed during glaciation.



SOURCE: LEMKE, 1960.

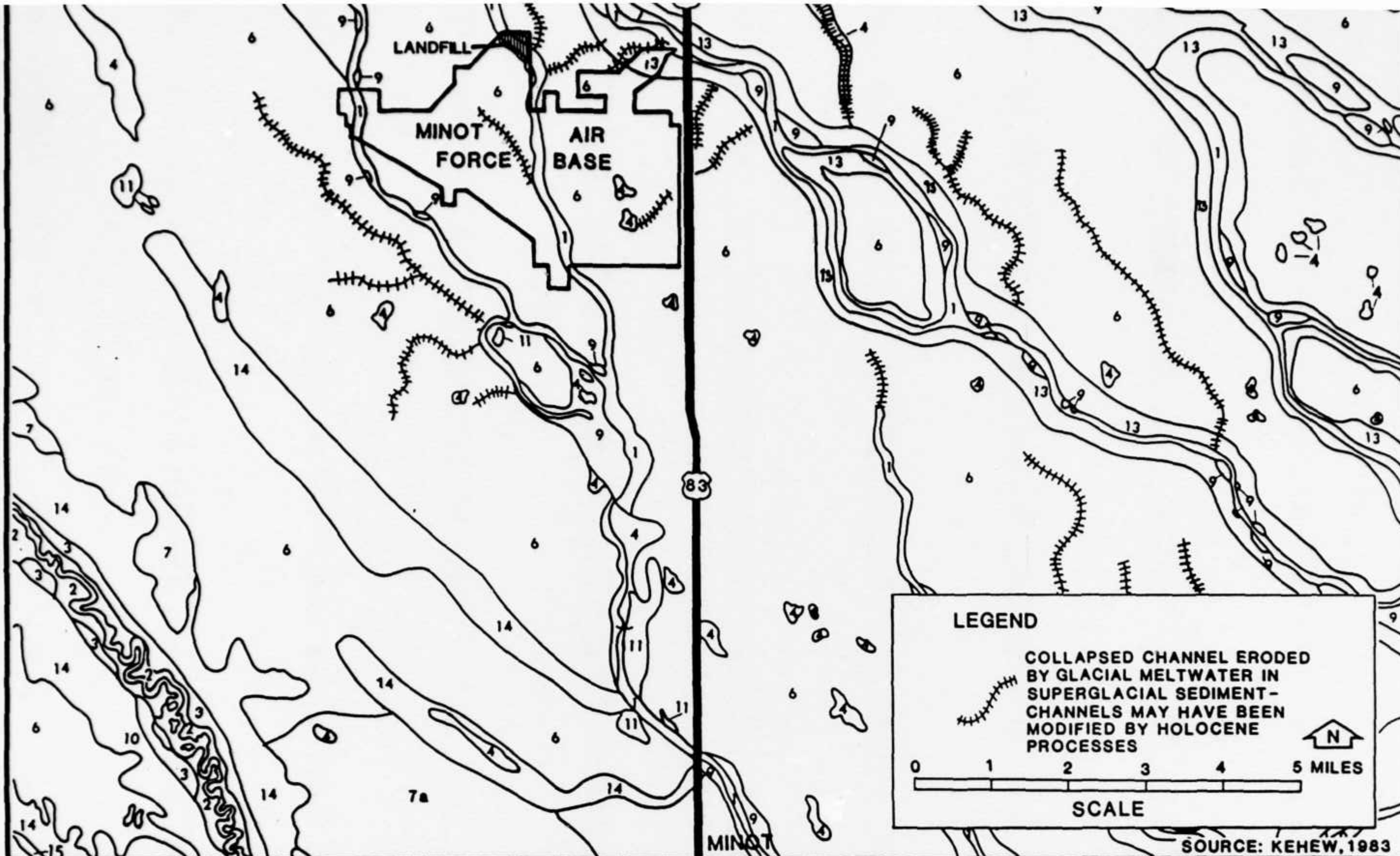


Figure 3.3-3
GEOLOGY OF NEAR SURFACE MATERIALS
(See Table 3.3-2)

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Table 3.3-2. Geologic Properties of Near Surface Materials (Page 1 of 2)

Map Unit	Formation Or Group	Description	Topography[1]	Orgin
1	Oahe Formation	Dark, obscurely bedded clay and silt; may overlie sand and gravel of Coleharbor Group.	Gently undulating	River, slope wash, pond, and wind-blown sediment, undivided, deposited in partially collapsed to non-collapsed stream channels.
2	Oahe Formation	Dark, obscurely bedded clay and silt; occasionally over-lying cross-bedded sand and gravel. Wood, shells, and bone fragments present.	Gently undulating	Overbank sediment deposited deposited on flood plains of modern streams; contains some channel sediment.
3	Oahe Formation	Dark, obscurely bedded sand to silty clay.	Gently undulating to undulating	River sediment deposited by ephemeral streams on sloping surfaces (alluvial fans) near the mouths of coulees.
4	Oahe Formation	Dark, obscurely bedded clay and silt.	Gently undulating	Pond and slough sediment.
5	Oahe Formation, Coleharbor Group, Fort Union Group undivided	Bedded sand, silt, clay, and lignite and/or non-bedded sand, silt, clay, and gravel (till). Bedding may be disturbed or distorted. Exposures may be out of place stratigraphically.	Undulating to rolling. Often occurs as a series of parallel ridges or blocks along valley sides.	Landslide deposits.
6	Coleharbor Group	Non-bedded and poorly sorted sand, silt, clay, pebbles, cobbles, and boulders (till).	Gently undulating to undulating	Glacial sediment deposited by collapse from stagnant glaciers.
7	Coleharbor Group	Non-bedded and poorly sorted sand, silt, clay, pebbles, cobbles, and boulders (till).	Undulating to rolling	Glacial sediment deposited by collapse from stagnant glaciers.

Table 3.3-2. Geologic Properties of Near Surface Materials (Continued, Page 2 of 2)

Map Unit	Formation Or Group	Description	Topography[1]	Orgin
7a	Coleharbor Group	Non-bedded and poorly sorted sand, silt, clay, pebbles, cobbles, and boulders (till).	High elevation because of glacial processes prior to last advance.	Glacial sediment draped over topography formed previous to or during last advance.
9	Coleharbor Group	Bedded sand and gravel.	Gently undulating to undulating.	River sediment deposited in bars usually located along inside bends of channel meanders.
11	Coleharbor Group	Cross-bedded sand and gravel; bedding disrupted and contorted.	Undulating to rolling.	River sediment deposited in contact with glacial ice.
13	Coleharbor Group	Non-bedded and poorly sorted sand, silt, clay, pebbles, cobbles and boulders (till).	Undulating to rolling; consists of anastomosing channel pattern in places.	Glacial sediment eroded by rivers.
14	Coleharbor Group	Non-bedded and poorly sorted sand, silt, clay, pebbles, cobbles, and boulders; contains patches of bedded sand and silty sand.	Rolling to hilly	Glacial sediment eroded by slope wash with sediment in bottoms of ravines.

[1] Slope angles; gently undulating (1°-2°), undulating (2°-4°), rolling (4°-8°), hilly (8°-15°).

The Coleharbor Group bedded sand and gravels exist in two meltwater channels in and adjacent to MAFB. The trend of the channels was controlled by active or stagnant glacial ice. They flowed south and east into glacial Lake Souris.

Holocene Oahe Formation deposits (10,000 ybp) overly the Coleharbor Group material in two distinct units. The bedded sand and gravel in the meltwater channels are covered by a thin blanket of organic clay and silt of the Oahe Formation. The sediment was deposited by streams, runoff from valley sides, and wind. In the southeastern part of MAFB, two small deposits of organic clay and silt have been recognized. Closed depressions occur in glacial collapse topography as a result of uneven subsidence of till when the stagnant ice melted beneath (Kehew, 1983). Sediment carried by runoff, wind and decomposing vegetation slowly filled the depressions.

Collapse channels modified by Holocene processes have also been mapped on MAFB by Kehew (1983). The channels were originally formed in the till on stagnant ice or they were buried by glacial sediment from the latest ice advance.

3.3.2 SOILS

The soils at MAFB consist primarily of silty loams derived from glacial till. Of the dozen soils and soil complexes represented in the study area, the Barnes and Hamerly soils make up about 90 percent (Figure 3.3-4). The following discussion lists the soils and soil complexes and some of their representative characteristics (USSCS, 1974).

Barnes-Svea Loams: This soil association is by far the predominant type found on MAFB. It is nearly level (0 to 3 percent slope) with slow runoff and some ponding common. Permeability is moderate to about 42-in where it then decreases to moderately slow with increasing depth. It's origin is from loamy glacial till and it forms the upland till plains commonly found in the area.

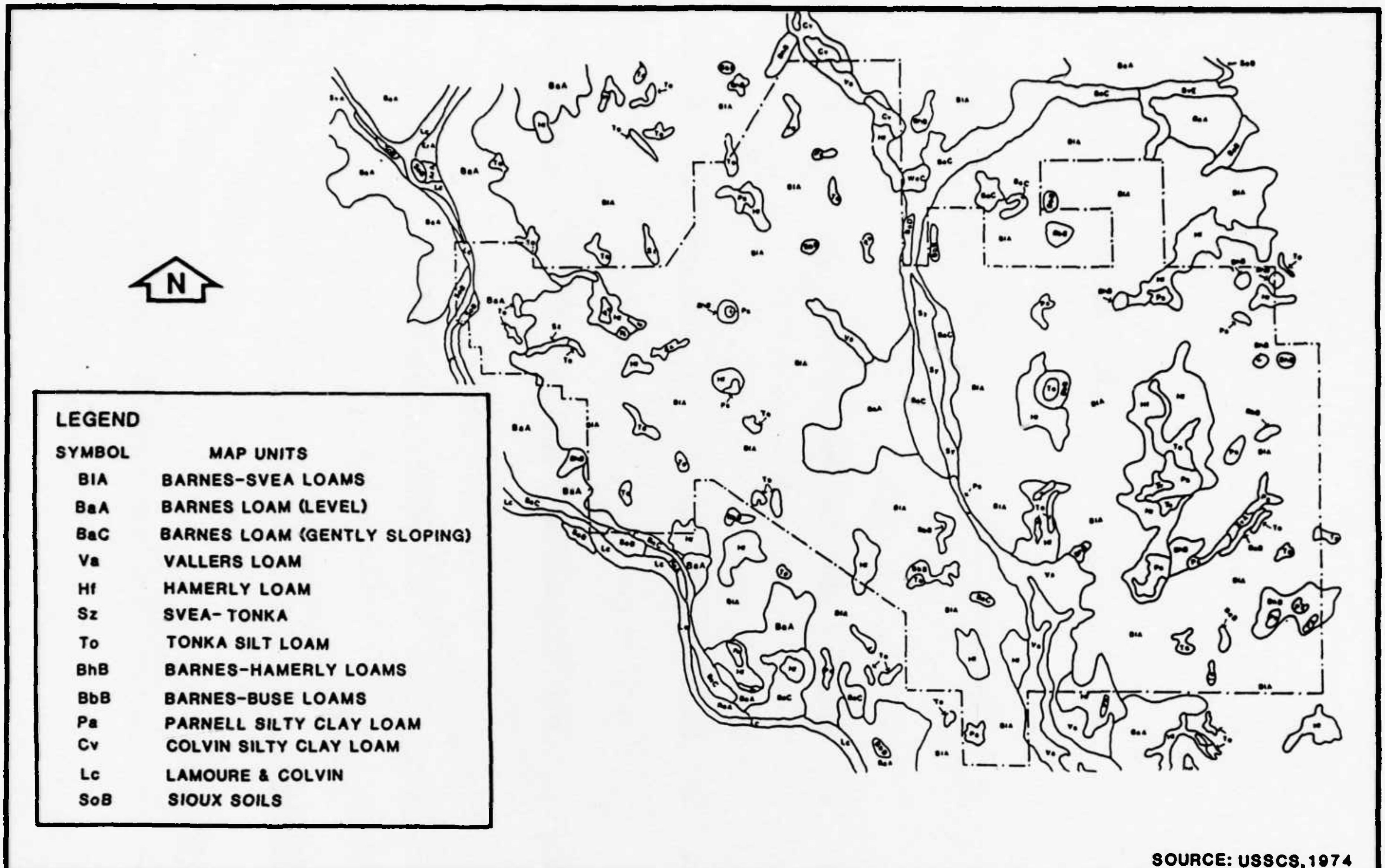

Figure 3.3-4
MAFB SOILS MAP

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Barnes Loam: The Barnes Loam is found in the center of MAFB and near the edge of the base to the west and northeast. It consists of level (0 to 2 percent) and smooth till plains derived from loamy glacial till. Gently sloping Barnes Loam has been mapped along the north-south trending meltwater channel forming the intermittent stream flowing to Egg Creek. It is characterized by medium runoff, moderate permeability, and found on smooth slopes that grade from the uplands toward the drainageways.

Hamerly Loam: This soil is found throughout the base in small irregular mapped units. It is generally sloping (1 to 5 percent) with slow to medium runoff and moderately slow permability. It was formed from glacial till and is found along the rims of potholes and in the swales between potholes.

Vallers Loam: This soil is found in the southern and central parts of the study area. It is level (0 to 2 percent) with slow runoff, moderately slow permeability, and high water content during spring and other wet periods. The Vallers Loam originates from loamy glacial till or till plains and forms the low areas around potholes and sloughs and is also found in low swales. It is a deep, saline soil with the salts common in the surface layers.

Barnes-Buse Loams: This complex is found on the crests of knolls and small ridges in small areas that are irregular in shape. The relief is undulating (3 to 6 percent) with medium surface runoff and moderate permeability.

Barnes-Hamerly Loams: This soil complex is around and between depressions on the till plains. The areas are small in size and irregular in shape. It has undulating relief (1 to 6 percent) and runoff is slow to medium and permeability is moderate to moderately slow.

Colvin Silty Clay Loam: This soil is level (0 to 1 percent) and poorly drained with the water table commonly near the ground surface. The soil was formed in glacio-lacustrine and outwash material and it is located in the low parts of glacial lake basins and on drainages on outwash plains. The soil permeability is usually moderate.

Parnell Silty Clay Loam: This level (0 to 1 percent) and poorly drained soil is found in basins and depressions on till plains. It's origin is fine textured alluvium and it usually has a slow soil permeability.

Svea-Lamoure Complex: This level to gently undulating (0 to 4 percent) soil is found in narrow drainageways and the bottomland at the base of fans. On MAFB, it is found along the meltwater channel flowing towards Egg Creek. Permeability is moderate to moderately slow.

Tonka Silt Loam: Formed in glacial alluvium and found in shallow depressions and potholes, the Tonka Silt Loams are scattered throughout the study area in small, level (0 to 1 percent) patches that commonly either flood or pond during wet periods. It usually has a very rapid permeability.

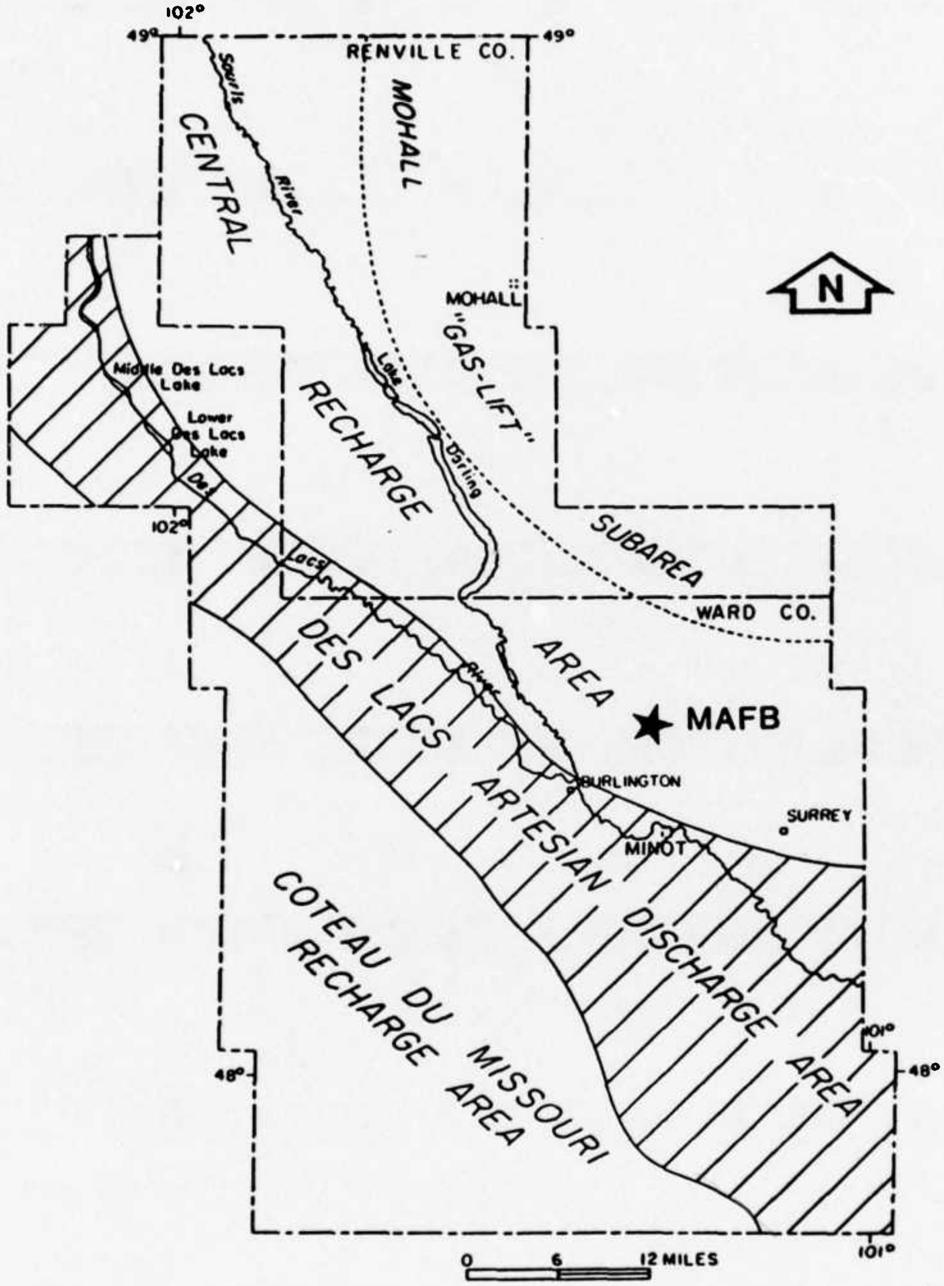
Sioux Series: This series consists of level and undulating, excessively drained soils that formed in sand and gravel outwash material on outwash plains. Small areas of this series are found in the west portion of the MAFB along a meltwater channel flowing southeast towards Livingston Creek.

3.3.3 GEOHYGROLOGY

All ground water of economic significance in the study area is meteoric (derived from precipitation). Aquifers exist in both the bedrock and the unconsolidated glacial deposits. Local ground water is the source of domestic and agricultural water in the area surrounding MAFB.

MAFB lies in the Central Recharge Area as defined by Pettyjohn and Hutchinson (1971) (Figure 3.3-5). In most of the Central Recharge Area, wells tapping glacial drift have higher water levels than nearby bedrock wells. This indicates that net ground water movement is downward and that ground water in the unconsolidated sediment is recharging the bedrock aquifers throughout this area.

Forty-seven percent of domestic and livestock wells in Renville and Ward counties are bedrock wells according to Pettyjohn and Hutchinson (1971). The Upper Cretaceous Fox Hills and Hell Creek formations are used for water supplies in the area but their yield to wells may be small.



SOURCE: PETTYJOHN & HUTCHINSON, 1971

Figure 3.3-5
MAJOR GROUND WATER RECHARGE AND DISCHARGE AREAS

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The Paleocene Fort Union Group is the uppermost bedrock aquifer. Lignite and fine-grained sandstone yield small to moderate amounts of ground water to wells. Recharge occurs by seepage of surface water (rivers), precipitation on outcrops southwest of MAFB, and by infiltration from glacial aquifers. Some wells screened in lignite contain an appreciable quantity of dissolved gas in the water. This is fairly common just a few miles north of MAFB (Mohall "Gas-Lift" Subarea). Methane gas accumulates in fractures and high porosity areas of lignites and the gas may provide enough lift to raise water to the surface when tapped by a well.

Most ground water wells in the Minot area produce water from glacial material. Kehew (1983) states that all significant aquifers in the Minot area are in Coleharbor and Oahe formation glacial deposits. With the exception of deposits in present and ancient stream valleys, there are no widespread buried deposits of water-bearing sand and gravel in Ward County. Most wells tapping glacial aquifers are drilled through the glacial till into sand and gravel deposits. The clayey till generally yields little or no water to wells (Pettyjohn and Hutchinson, 1971).

Forty-four of 122 shallow soil borings on base completed by September 1983 have measurable water levels that were primarily in silty, sandy or gravelly water-bearing clays. Water levels taken in boreholes ranged from 3 to 19 ft (average 13 ft) below ground surface. The boreholes ranged from 10 to 30 ft in depth (average 17.5 ft). The water level data were not sufficient to derive conclusions on ground water flow patterns.

Three major aquifers, the Minot, North Hill, and Northwest Buried Channel aquifers, exist 6 to 12 miles south of MAFB (Figure 3.3-6). All three consist primarily of sand and gravel outwash deposits. The Minot aquifer is up to 50 ft thick and is considered to be under confined conditions (although ground water occurs under water table conditions, also). In addition to natural recharge, the city of Minot constructed an artificial recharge facility in 1965. Information regarding its present status was not found.

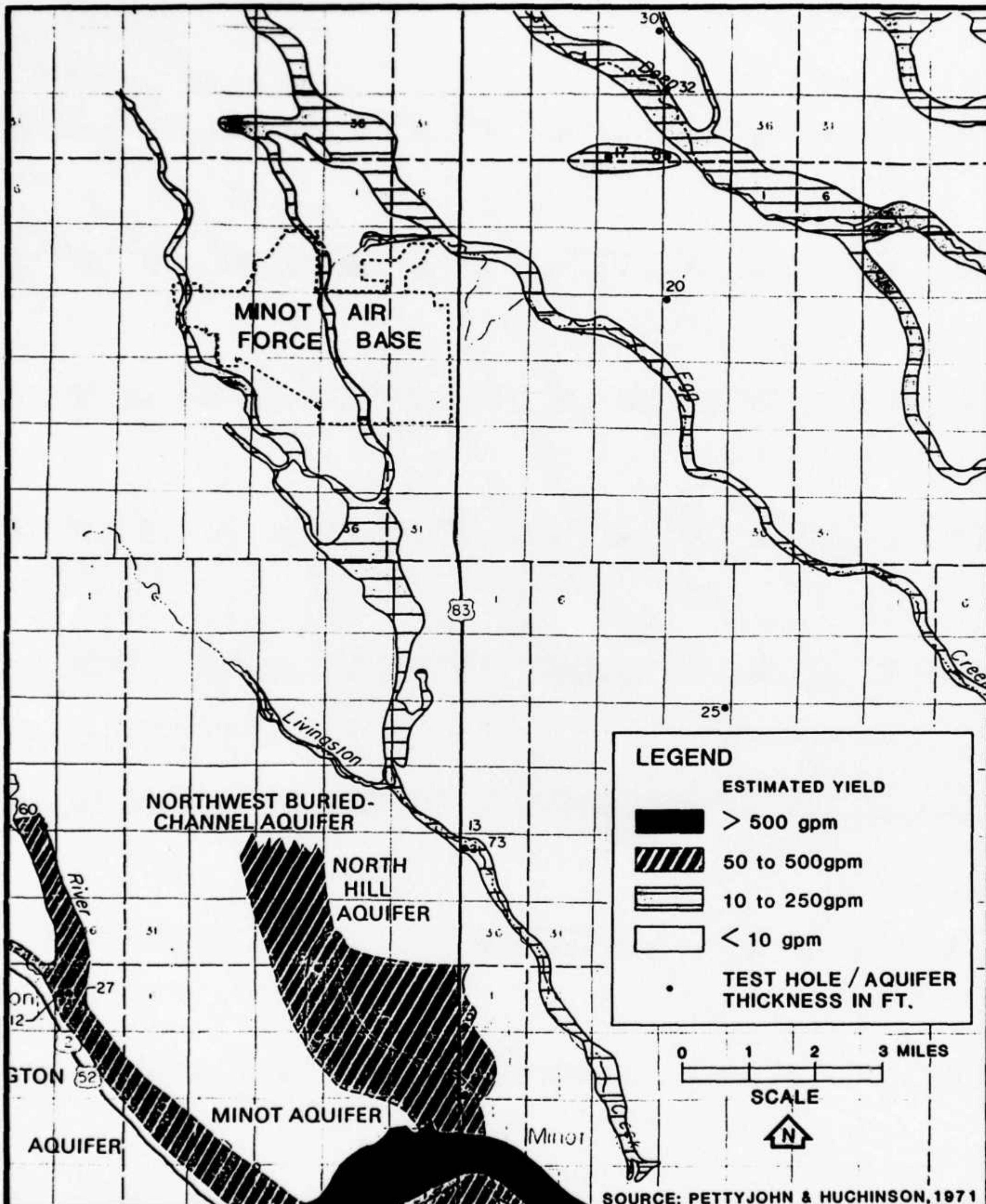

Figure 3.3-6
MAJOR AQUIFERS

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The North Hill aquifer lies north of Minot and is under artesian pressures. The aquifer is up to 30 ft thick in some locations. Regional ground water flow is to the south but additional information is needed to determine its areal extent, thickness and permeability. Its future for development is probably limited due to abrupt changes in thickness and limited recharge.

The Northwest Buried Channel aquifer is the closest mapped major aquifer to the MAFB (Pettyjohn and Hutchinson, 1971). Its boundaries and areal extent are also not well documented. It is artesian and varies considerably in lithology, thickness, and permeability.

Meltwater channels in Ward County can contain sufficient thickness of sand and gravel to be productive aquifers (Pettyjohn and Hutchinson, 1971). Egg Creek, to the northeast of MAFB, and the adjacent channels mapped on Figure 3.3-6 may contain water-bearing sand and gravel up to 20 ft thick. Recharge is almost exclusively from infiltration of precipitation and seepage of surface water (Egg Creek). Although narrow, their length and permeability permit infiltration of large amounts of water. Discharge is by underflow, evapotranspiration and pumping. The combination of high permeability and a water table within 15 ft of the ground surface allows these aquifers to be contaminated fairly easily. Ground water flow is relatively unimpeded along the channel axes, allowing the potential migration of contaminants over large distances.

3.4 WATER QUALITY

3.4.1 SURFACE WATER QUALITY

MAFB is basically drained by intermittent streams which are described in Section 3.3.2. Table 3.4-1 lists the water quality criteria for surface waters in North Dakota.

Egg Creek receives most of the surface drainage from MAFB. It is designated as a Class III stream by the North Dakota State Department of Health (NDSDH), indicating that the stream shall be suitable for industrial and agricultural uses. MAFB lagoon cells discharge to the creek, and the contribution by the lagoons to the stream ranges from 30 to 100 percent of

Table 3.4-1. Specific Standards of Surface Water Quality North Dakota State Department of Health Regulation 61-29-02 (1977)

Substance or Characteristic	Class of Stream			
	I	IA	II	III
	Limitation mg/l***			
Ammonia	0.02	0.02	0.02	0.10
Arsenic	0.05	0.05	0.05	0.10
Barium	1.0	1.0	1.0	1.0
Boron	0.5	0.5	0.5	0.75
Cadmium	0.01	0.01	0.01	0.01
Chloride	100	175	250	250
Chromium	0.05	0.05	0.05	0.05
Copper	0.05	0.05	0.1	0.1
Cyanide	0.005	0.005	0.005	0.1
Lead	0.05	0.05	0.05	0.1
Nitrate	1.0	1.0	1.5	1.5
Phosphate	0.1	0.1	0.2	0.2
Zinc	1.0	1.0	2.0	2.0
Selenium	0.01	0.01	0.01	0.01
Polychlorinated Biphenyls (µg/l)	0.001	0.001	0.001	0.001
Dissolved Oxygen	5.0	5.0	5.0	5.0
Phenols	0.01	0.01	0.01	0.01
Sulfate	250	450	450	750
Total Chlorine Residual	0.01	0.01	0.01	0.01
Mercury	0.002	0.002	0.002	0.002
pH (Standard Units)	7.0-8.5	7.0-8.5	6.0-9.0	6.0-9.0
Temperature*	85°F	85°F	85°F	85°F
Fecal Coliform**				
Sodium	50 percent of total cations as meq/l			

* - The maximum increase shall not be greater than 5°F above natural background conditions.

** - The fecal coliforms (f.c.) shall not exceed a geometric mean of 200 f.c./100 ml based on a minimum of five samples obtained during separate 24 hour periods of any 30 day period nor shall 10 percent of total samples exceed 400 f.c./100 ml. This standard shall apply only during May 1 - September 30.

*** - Unless otherwise indicated.

the total flow of the stream. Presented in Table 3.4-2 are water quality data for the U.S. Geological Survey monitoring location nearest to MAFB (28 miles southeast of MAFB). The data are somewhat limited in sampling frequency but suggest that Egg Creek at that point is largely in compliance with applicable state standards. The only exception is a somewhat elevated phosphate concentration, which is not reasonably attributed to MAFB operations.

In addition to the U.S. Geological Survey monitoring program, surface water quality in the vicinity of MAFB is also monitored by the Bioenvironmental Section of the USAF Hospital. The four monitoring sites are the Ditch "A" discharge (Site 1), the Ditch "B" discharge (Site 2), Egg Creek upstream of MAFB (Site 3), and Egg Creek downstream of MAFB (Site 4). Site 1 is located just past the lagoons where the main drainage ditch exits the base. This ditch receives runoff from the eastern half of the base, the entire housing area, and, occasionally the discharge from the adjacent secondary lagoon. Site 2 is located near the horse stables where Ditch "B" leaves the base. The ditch receives the runoff from the western half of the base and an occasional discharge from the other secondary lagoon. Site 3 is upstream of the points where the ditches enter Egg Creek, and Site 4 is downstream of the points where the two ditches enter Egg Creek. The monitoring locations are shown in Figure 3.4-1.

MAFB water quality from the period 1981 through 1984 shows that the two ditches frequently have concentrations of ammonia, sulfate, and phosphate in concentrations above state standards. Less frequently, concentrations of dissolved oxygen, pH, residual chlorine, arsenic, PCB, phenol, and nitrate have been determined to be outside state water quality criteria. These two ditches do not appear to have a significant effect on Egg Creek water quality, however, as the water quality measurements at Sites 3 and 4 on Egg Creek are similar. Measurements at Site 3, upstream of MAFB, show concentrations of ammonia, PCB, sulfate, phosphate, and cyanide at times above state standards and dissolved oxygen concentrations below standards. Site 4, downstream of MAFB, shows similar concentrations of these parameters, with infrequent measurements of residual chlorine and boron above standards.

Table 3.4-2. Water Quality Data for Egg Creek (28 Miles Southeast of MAFB).

Parameter	April 23	April 25	1979* May 1	June 9	July 16
Discharge CFS	691	484	140	7.6	32
Specific Conductance	315	312	570	1660	630
pH (units)	7.6				
Temperature °C	4.5	4.5	11.0	16.0	23.0
Hardness, mg/l $CaCO_3$	110.0	--	--	--	--
Hardness-Noncarb., mg/l	50	--	--	--	--
Sodium, mg/l	18	--	--	--	--
Sodium Adsorption Ratio	.7	--	--	--	--
Sulfate, mg/l	76	--	--	--	--
Chloride, mg/l	7.2	--	--	--	--
Fluoride, mg/l	0.1	--	--	--	--
Nitrogen (NO_2+NO_3), mg/l	1.5	--	--	--	--
Phosphorus, mg/l	0.32	--	--	--	--
Arsenic, μg/l	1.0	--	--	--	--
Barium, μg/l	30	--	--	--	--
Boron, μg/l	60	--	--	--	--
Cadium, μg/l	1	--	--	--	--
Chromium, μg/l	0	--	--	--	--
Copper, μg/l	0	--	--	--	--
Lead, μg/l	0	--	--	--	--
Selenium, μg/l	0	--	--	--	--
Zinc, μg/l	30.	--	--	--	--

* -- No available data.

Source: USGS, 1980.

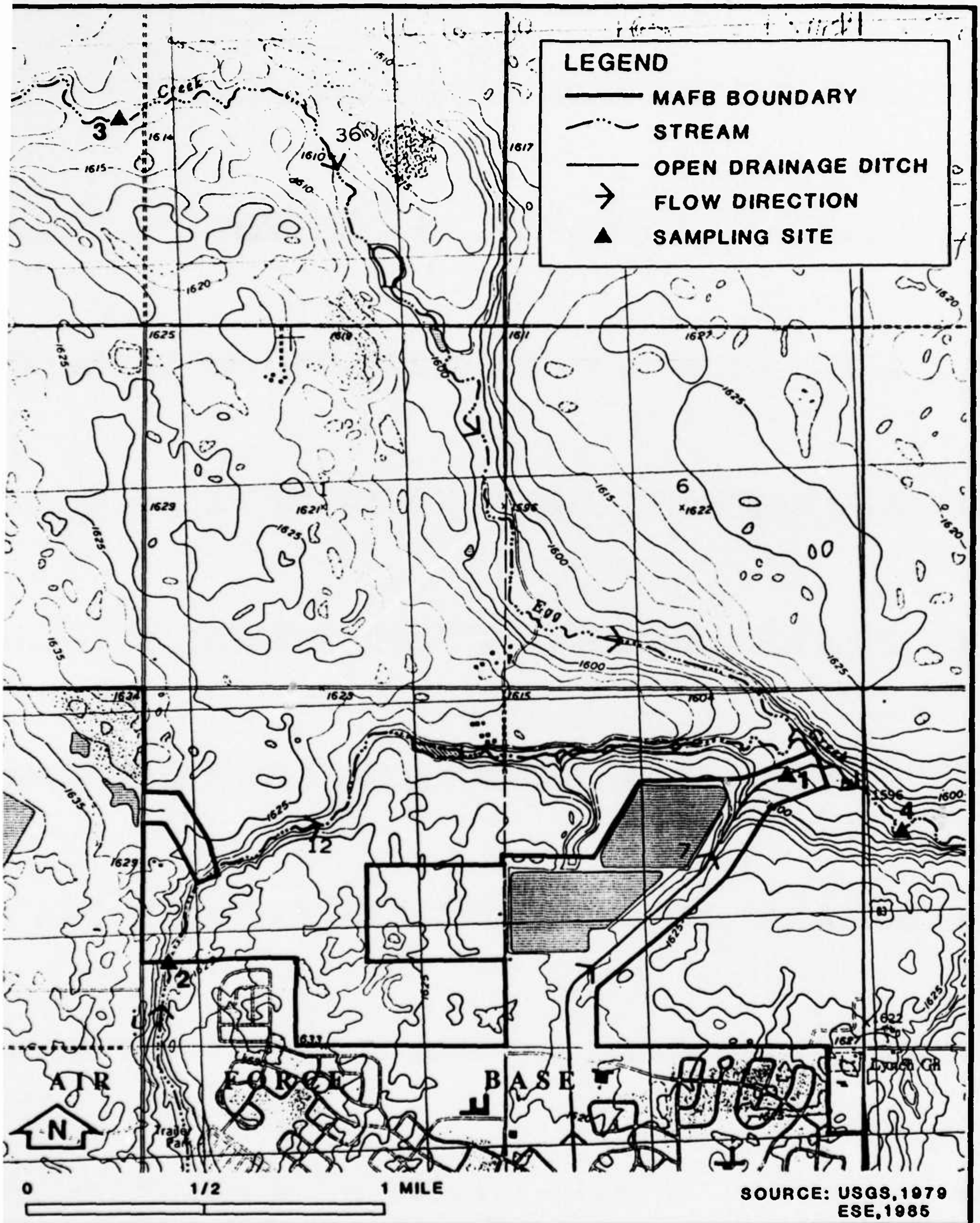

Figure 3.4-1
SURFACE WATER SAMPLING SITES

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RESTORATION PROGRAM
Minot Air Force Base

The base obtains drinking water from the city of Minot. The source of the water is city-owned well fields supplemented by water from the Souris River. Water is transported to the base through a 15 mile long pipeline. The river is designated a Class IA by the NDSDH meaning the quality of water shall be such that after treatment consisting of coagulation, settling, filtration, softening and chlorination, the water will meet the requirements of the NDSDH for municipal use.

3.4.2 GROUND WATER QUALITY

The Tertiary aquifer underlying the base are rocks of the Fort Union Group. Ground water is produced primarily from lignite beds. Water from the Fort Union Group in the vicinity of the base is of the sodium bicarbonate chloride or sodium chloride bicarbonate type.

Ground water from glacial deposits is variable in chemical quality. Locally, sulfate concentrations may be high enough to render the water unsuitable for many uses.

Prior to 1916, aquifers in the Souris River Valley discharged water to the river, but increased use of the glacial aquifers resulted in a reverse direction of recharge during most of the year. Dissolved solids concentrations in the Souris River are high in November and December during low flow periods and low in April during the spring runoff. Recharge to the major shallow aquifers by surficial water and infiltration makes them susceptible to contamination. Sources of ground water pollution in the area include the Souris River, septic tanks, cesspools, manure piles and refuse dumps. The Minot aquifer (Figure 3.3-6) may have increased recharge from the bedrock aquifers due to increased withdrawal but no specific changes in water quality have been detected. An increase in salinity and dissolved solids would be expected with increased recharge from the bedrock.

The Minot aquifer has been subdivided into at least four parts with different chemical compositions. Generally the water is a sodium bicarbonate type. Data from 14 city-owned wells in the Minot aquifer indicate the total disssolved solid concentration is about 1,000 parts per

million (ppm), in excess of the National Secondary Drinking Water Regulation Standard of 500 ppm (Table 3.4-3). The secondary drinking water standards are based on aesthetic considerations, and the dissolved solids concentrations do not represent a threat to human health (Pettyjohn and Hills, 1965).

Ground water from the North Hill aquifer south of MAFB is a calcium sulfate type with very high dissolved solids. The Northwest Buried-Channel aquifer is a bicarbonate type with high levels of chloride and iron. The water from both aquifers is of marginal quality for most uses.

MAFB is in the central recharge area as discussed in Section 3.3.3. Wells in this area penetrate a wide variety of material and ground water quality varies significantly. Water in the surficial sand and gravel deposits, such as ice marginal channels, generally is a calcium bicarbonate type with dissolved solids less than 1,000 ppm. The buried channel aquifers are considerably more mineralized and varying from calcium sulfate to sodium sulfate with depth. The most abundant chemical constituent is sulfate. Sulfate concentrations increase with increasing well depth. The higher concentration of sulfate in shallow wells presumably is due to soil leaching. Poor drainage does not permit the removal of sulfate and therefore soluable salts tend to accumulate. Despite the low permeability of the glacial till, infiltrating water can carry the sulfate to underlying sand and gravel aquifers (Pettyjohn and Hutchinson, 1971).

Figure 4.3-2 shows the locations of four monitoring wells installed in the sanitary landfill at MAFB. A glacial meltwater channel trends north through the landfill location (Figure 3.3-3). The channel forms a minor aquifer (yield 10 to 250 gallons (gal) per minute) recharged by infiltration and is therefore susceptable to contamination from the landfill. The monitoring wells have been sampled and the leachate consists of heavy metals and phenols believed to have originated from garbage or possibly hazardous waste placed in the landfill. An old trench at the site may be collecting some of the estimated 10,000 to 25,000 gal of leachate. The borehole logs of the

Table 3.4-3. Maximum Contaminant Levels According to the National Interim Primary and Secondary Drinking Water Regulations

Contaminant	Standard (mg/l)*
I. Primary Standards:	
<u>Inorganic Contaminants</u>	
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate	10.0
Selenium	0.01
Silver	0.05
<u>Organic Contaminants</u>	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.10
Toxaphene	0.005
2,4-Dichlorophenoxyacetic Acid	0.1
2,4,5-TP Silvex	0.01
Total Trihalomethanes	0.10
<u>Radionuclides</u>	
Gross Alpha Particle Activity	15 (pCi/l)
Radium-226 + Radium-228	5 (pCi/l)
Tritium	20,000 (pCi/l)
Strontium-90	8 (pCi/l)
II. Secondary Standards	
Chloride	250
Color	15 (color units)
Copper	1.0
Corrosivity	(Non-corrosive)
Foaming Agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 (TON)†
pH	6.5 - 8.5
Sulfate	250
Total Dissolved Solids	500
Zinc (Zn)	5

* - Unless specified in parentheses ( ).
† TON = Threshold Odor Number.

four monitor wells indicate the area may be underlain by up to 40 ft of clay. Well 4 is in more gravelly material and is believed to be water-bearing. It is located on the opposite side of the meltwater channel.

Three soil boreholes (40 ft deep) completed in the landfill during May of 1977 had measurable water levels from 8 to 21 ft below the land surface after one or two days. The boreholes encountered predominantly silty clay but water-bearing and moist sandy to gravelly lenses were found in each borehole.

3.5 BIOTA

MAFB is located in the transitional grassland region of central North Dakota (Dodd, 1979). The development of facilities has resulted in the disturbance of natural habitats over most of the base.

Grassland habitat is present adjacent to runways, munitions storage bunkers, and in the landfill area. Native grasses such as blue grama grass (*Bouteloua gracilis*) and western wheatgrass (*Agropyron smithii*) occur in these areas, but introduced weedy species are also present. Weedy species observed on MAFB include barnyard grass (*Echinochloa crusgalli*), downy brome (*Bromus tectorum*), green foxtail (*Setaria viridis*), and crested wheatgrass (*Agropyron cristatum*).

No native woodland habitat is present on the base, but green ash, Russian olive, spruce, and junipers have been planted to provide windbreaks and landscaping near base facilities. Mature stands of trees provide shelter and limited forage for several bird species.

Few wildlife species inhabit the base because of the extent of base facilities and consequent reduction of suitable habitat. Those species which have been observed on MAFB are common in adjacent areas throughout the region. Mammals typically found in habitats on site include the Richardson ground squirrel (*Citellus richardsoni*), thirteen-line ground squirrel (*Citellus tridecemlineatus*), northern pocket gopher (*Thomomys talpoides*), white-footed mice (*Peromyscus* spp.), and whitetail jackrabbit (*Lepus townsendi*).

Bird species inhabiting the base are typical of disturbed areas and human habitation throughout the northern Great Plains. The rock dove (Columba livia), mourning dove (Zenaidura macroura), house sparrow (Passer domesticus), and eastern kingbird (Tyrannus tyrannus) are common species on the base. Franklin's gull (Larus pipixcan) is common in the vicinity of nearby lakes and reservoirs and is an occasional visitor to the base. This species was common in the past in the vicinity of the open landfill, but is no longer a problem near base facilities (Clark et al., 1977). Limited wetland habitat dominated by cattails (Typha spp.) and sedges (Carex spp.) occurs along drainageways within the base boundaries. These areas provide breeding and foraging habitat for a few ducks which inhabit the base.

MAFB is situated 8 miles southeast of upper Souris National Wildlife Refuge (NWR), 30 miles southeast of Des Lacs NWR, and 30 miles southwest of J. Clark Salyer NWR. Each of these refuges contain large impoundments which provide open water and wetland habitat. Reservoirs provide fishing for game and nongame fish such as walleye, largemouth and smallmouth bass, bullhead, and sunfish.

These three refuges are major staging areas for migratory waterfowl and there is considerable movement of birds among these refuges prior to fall migration. Important species which use these refuges include migratory waterfowl, sandhill and whooping cranes, bald eagles, and peregrine falcon.

Amphibians and reptiles which inhabit the base and adjacent areas are common throughout North Dakota and the northern Great Plains (Wheeler and Wheeler, 1966). Toads (Bufo spp.), the northern leopard frog (Rana pipiens), and plains garter snakes (Thamnophis radix) are typical of habitats on and near MAFB.

No threatened or endangered plant or animal species are known to inhabit MAFB and its subinstallations. Highly mobile species such as the bald eagle, peregrine falcon, and whooping crane (all of which are listed as federally endangered) may ocassionally occur in the vicinity of MAFB but are unlikely to visit the base due to the limited extent of suitable habitat and high degree of human activity.

Limited grassland habitat is available at the Fortuna Radar Site in northwestern North Dakota. Ground squirrels, whitetail jackrabbits, mourning doves, and house sparrows typically inhabit the area. The limited extent and high degree of human activity at the Bismarck Radar Site, USAF Regional Hospital in Minot, and at the Riverdale Recreation Area provide extremely limited suitable habitat for plants or wildlife species.

4.0 FINDINGS

To assess hazardous waste management at MAFB, past and current waste generation and disposal methods were reviewed. This section presents a summary of hazardous wastes generated by base functions, a description of waste disposal methods, an identification of the onbase disposal sites, and an evaluation of the potential for environmental contamination. This information was obtained by a review of files and records, interviews with current and former MAFB employees, and site inspections.

4.1 ACTIVITY REVIEW

MAFB operations described in this section are those which handle, store or dispose of potentially toxic or hazardous materials. These operations include industrial and laboratory operations and activities in which pesticides; polychlorinated biphenyls (PCBs); petroleum, oils, lubricants, (POL); and explosives are handled. No large-scale manufacturing operations have been conducted at MAFB. Rather, the industrial operations described in the following subsections are primarily maintenance-support functions provided for base facilities, aircraft, missiles, vehicles and ground equipment.

The installation generates approximately 80,000 gal/yr of predominately liquid waste material. Recoverable JP-4 which is handled by Liquid Fuels Management accounts for approximately 50 percent of the total liquid waste generated. Petroleum and synthetic lubricating and hydraulic fluids, sold to contractors through the Defense Property Disposal Office (DPDO), account for approximately 32 percent (26,000 gal/yr) of the total. About 8,000 gal/yr of the liquid waste (10 percent), consist of hazardous waste currently regulated either under TSCA or RCRA. The remaining 8 percent of the waste consist of aircraft soaps, separator sludges, and other waste which are disposed of or recovered in a controlled manner.

4.1.1 INDUSTRIAL OPERATIONS

This section describes the industrial activities within each unit which generate hazardous wastes, waste POL and aircraft detergents. A master list of shops at MAFB is included in Appendix D.

91st SMW

Industrial operations in the 91st SMW occur in three squadrons: the 91st Field Missile Maintenance Squadron (FMMS), the 91st Transportation Squadron, and the 91st Supply Squadron.

The 91st FMMS industrial operations are located primarily in Building 546. The primary waste generators are Power Electric, Pneudraulics, Corrosion Control and Periodic Maintenance. Power Electric generates waste lube oils from the annual service of 8 tractors. Waste battery acid and sodium chromate are also handled at Power Electric. Batteries used for starting diesel engines and emergency power are occasionally drained of waste battery acid. Waste sodium chromate solutions (99 percent water) are generated from maintenance operations at missile sites.

Corrosion Control, which has been in operation approximately 5 years, performs small painting jobs which generate small amounts of residual methyl ethyl ketone (MEK) on brushes and rags.

The Pneudraulics shop, which performs maintenance on all hydraulic systems in the 91st SMW (e.g., transporter erector) and pneumatic systems for equipment in the entire wing, generates waste hydraulic oil as a primary waste.

Periodic Maintenance performs maintenance at the missile sites, generating large quantities of a water-diesel fuel mixture.

The 91st Transportation Squadron performs complete maintenance on all government registered vehicles at MAFB. Operations performed by this squadron include oil servicing, solvent degreasing, engine tuneup, major repairs, battery replacement and brake repair. Large quantities of waste synthetic oils and petroleum oils are generated from maintenance operations. Twenty batteries are serviced each month, generating waste battery acid. Paint residue and thinners, PD-680 and aircraft cleaning soap are generated from degreasing and cleaning activities.

The 91st Supply Squadron operates the Fuels Control Center at Building 420, which generates waste aircraft cleaning soap and small quantities of lube oils. A service station within the Supply Squadron handles waste lube oils and solvents from the minor maintenance and repair of personal vehicles. Another base service station dispenses only MOGAS--no waste lubricating oils or solvents are generated.

<u>5th BMW</u>

The 5th BMW is supported by Organizational Maintenance, Field Maintenance, Avionics Maintenance and Munitions Maintenance Squadrons. Operations are conducted for the B-52H "Stratofortress" and KC-135 "Stratotanker", as well as for ground equipment used within the wing.

Organizational Maintenance Squadron (OMS) is primarily responsible for periodic maintenance. Before the aircraft equipment is checked, it is washed with alkaline aircraft soap and solvents.

The 5th Field Maintenance Squadron (FMS) is comprised of the the Aerospace Ground Equipment (AGE) Branch, the Aerospace Systems Branch, and the Fabrication Branch. AGE, in Building 995, is responsible for maintaining flightline supporting equipment. This includes mechanical overhauls, oil changes and general mechanical repair.

The Aerospace Systems Branch performs maintenance on the aircraft in the wing. Within the branch the Hydraulic Shop (Building 857), Repair and Reclamation Shop (Building 857), and Wheel and Tire Shop (Dock 3) all use PD-680 in cleaning operations. The electric shop, which repairs the electrical systems on B-52s, KC-135s and helicopters, is required to change batteries on aircraft routinely, and handles waste battery acid.

The Fabrication Branch has a corrosion control shop which uses aircraft soap, PD-680, MEK and toluene in the washdown of aircraft. Polyurethane and enamel paint residues are also produced by painting operations.

The 5th Avionics Maintenance Squadron (AMS) includes the Fire Control Shop (Building 859) which uses PD-680 and Electronic Countermeasures which uses

MEK, toluene, and 1,1,1-trichloroethane in small quantities. Short Range Attack Missile (SRAM) of the 5th MMS cleans electronic aircraft parts.

91st Combat Support Group (CSG)

The 91st CSG is responsible for providing support for all operational units at MAFB. Under the 91st CSG are three squadrons: the 91st Civil Engineering Squadron (CES), the Headquarters Squadron and the 91st Services Squadron.

The 91st CES has several industrial operations located in or in proximity to Building 445: (1) The paint shop which uses naptha and generates small quantities of waste paints, (2) the Liquid Fuels Section in Building 445 which handles oil/water separator pumping and tank cleaning operations, and (3) the Exterior Electric Shop in Building 470 which maintains all the high voltage on the base (e.g., lights on runway). This is the only shop which handles PCB-contaminated substances.

Under the Headquarters Squadron, an Auto Hobby Shop is available to current and retired base employees. Lube oil changes and PD-680 usage account for the majority of the wastes.

The Services Squadron has a service station which generates waste similar to that of the Hobby Shop.

5th Fighter Interceptor Squadron (FIS)

The 5th FIS is the largest non-SAC tenant stationed at MAFB. Waste generators include Corrosion Control, Pneudraulics and AGE. Corrosion Control is a much smaller operation than the one found at the 5th BMW, performing only touch-up painting on aircraft. MEK, laquers, thinners and toluene are used in aircraft cleaning and are generated as a waste. The Pneudraulics Shop uses large quantities of 1,1,1-trichlorethane and some PD-680. The AGE branch at 5th FIS is much smaller than that found at 5th BMW. PD-680 and aircraft soap are used in cleaning operations at AGE. Small amounts of MEK, thinners and paints are used in touch-up jobs performed in shops throughout the 5th FIS.

Det. 7, 37th Aerospace Rescue and Recovery Squadron (ARRS)

Minor maintenance is performed on helicopters at this squadron, not major overhauls.

2150th Communications Squadron

The 2150th Communications Squadron is responsible for the management, operation and maintenance of most communications, electronics and air traffic facilities on MAFB. 1,1,1-Trichloroethane is a primary solvent used in maintenance operations, along with denatured alcohol, paint, and adhesives.

Other Operations

Training activities at MAFB include firefighter training and small arms practice. Fire training exercises are conducted regularly using JP-4 as fuel and using water and Aqueous Film Forming Foam (AFFF) as suppressants. The small arms range, located south of the landfill, uses an earthen berm to catch lead slugs fired in small arms training.

Fortuna AFS

The Fortuna Radar site, located near Fortuna, N.D., operated from 1951 to 1979. The facility is currently on caretaker status. The only activities which are ongoing are minor facility maintenance, vehicle maintenance, and the operation of a heating plant and water treatment plant.

During the active years, minor cleaning and maintenance of radar equipment occurred in the AC&W Operations Buildings (Buildings 1 and 2). Small quantities of 1,1,1-trichloroethane used in cleaning was absorbed into rags. No waste solvent was reported to have been collected. Facility maintenance included plumbing, painting, and other general maintenance. In the past, most large painting jobs were contracted out. Presently, only touch-up work with water-based paints is performed. MAFB handles all pesticide and herbicide spraying at this site.

Vehicle maintenance occurs at the Auto Maintenance Shop (Building 30) and the Auto Hobby Shop (Building 55). Only tuneups and minor maintenance is performed at these buildings, resulting in very small quantities of waste

lube oil and solvents. In the past, approximately 15 government vehicles (including heavy equipment) were serviced at this site. Currently, only two vehicles are serviced onbase.

The onbase heating plant is oil-fired. Three boilers are currently operational although the plant ceased operation in 1983. The plant coverted from using coal to fuel oil around 1968, and formerly operated 4 boilers. The ash from coal use was reportedly buried onsite. Reportedly, no solvents or lube oils are generated from heating plant operations.

The Electric Primary Power Building (Buidling 38) formerly supplied onbase power to radar equipment from the operation of four 800-kilowatt generators. Diesel engines were used to drive the generators. Waste oil from diesel engine oil changes was stored in underground (6,000 gal) tanks near Building 2. The power plant ceased operation in 1979.

Hydrochloric acid is used in backwashing the filters at treatment plant. The acid is stored in 1,000 gal stainless steel tanks. Backwash water enters a drain and piped to a low spot on base property, where water is left to evaporate or infiltrate into the soil. The backwash water is highly diluted and does not pose a threat to the environment. Water from a similar system at a Minot radar site was tested and found to be safe to discharge.

Initially, septic tanks were used for sanitary sewage. Later, a small lagoon was excavated west of the septic tanks and used until 1975. Currently, a larger lagoon located west of the old lagoon (now dry) is used to treat all sanitary sewage. The lagoon infrequently discharges to a nearby valley. No rivers or other water bodies are located near the lagoon.

The skeet range at Fortuna AFS was closed in 1975. The ammunition was reportedly fired into the side of a hill. Scheduled maintenance performed on the range during operation could not be substantiated.

4.1.2 FUELS/OIL HANDLING, STORAGE AND DISPOSAL

The types of POL used and stored at MAFB include heating fuel oil (FO), JP-4, MOGAS, diesel fuel (DF), petroleum-based solvents, hydraulic fluids and lubricating oils.

The type of storage used is underground (UG) in tanks, or aboveground (AG) in tanks, bowsers or servicing vehicles. Nearly all POL storage facilities with capacities above 660-gal are UG tanks, except for large FO tanks in the POL storage area; servicing vehicles used to dispatch JP-4, and miscellaneous POL stored by Base Supply in a drum storage yard. The POL storage area, located approximately one-quarter mile east of the SAC Apron, has an 840,000 gal capacity and two 105,000 gal capacity AG fuel storage tanks. The tanks are enclosed by an earthen berm for secondary containment. Oil spills from this general area are directed to an oil/water separator east of the area. Several mobile fuel servicing vehicles are used to dispatch JP-4 to the flightline. The service vehicles, which range in size from 5,000 to 10,000 gal capacities, are located in a controlled area. The drum storage area near Building 422 is used by Base Supply to store PD-680, miscellaneous lubricants and other liquids. The barrels are stored sideways by means of a barrel rack. There is currently no containment in this area to prevent migration of spillage. Various other AG tanks, averaging 300 gal capacity, are used throughout the base (see Table 4.1-1). The majority of these tanks are FO tanks.

All base storage tanks (AG,UG) which are equipped with filters at the inlet and have interior coatings are inspected and/or cleaned once every 8 years. If the tanks do not have the aforementioned features, they are inspected and/or cleaned every 6 years. A project is currently underway to replace the seals and alter the floors of the two largest JP-4 storage tanks. An impervious clay liner will also be installed beneath these two tanks.

Fuel Oil Storage and Disposal

The large FO tanks store #6 FO as a backup fuel at the Heating Plant. No major spills have been recorded at the storage tanks or heating plant. The smaller FO tanks located at buildings throughout the base are used to store FO for heating purposes. This oil is consumed in-process and does not generate wastes, except for possible leaks or spills around transfer points.

Table 4.1-1. POL Storage Tanks by Location (Page 1 of 3)

POL Type	Capacity (1000 gal)	Facility No.	Location/ Building No.	Tank Type
MINOT AFB				
JP-4	5+ (x 2)	1963	POL Storage	AG
JP-4	30+	1964	POL Storage	AG
JP-4	20+	1961	POL Storage	AG
DF	15	1960	POL Storage	UG
MOGAS	16.8	1958	POL Storage	UG
MOGAS	50	1959	POL Storage	UG
FO	840	1978	POL Storage	AG
FO	105 (x 2)	1979	POL Storage	AG
Deicing Fluid	25	1997	POL Storage	AG
Cont. JP-4	8	2119	POL Storage	UG
Cont. Petro. Oil	0.9	2150	POL Storage	UG
Cont. Syn. Oil	1.8	2153	POL Storage	UG
MISC.	500+ *	--	Drum Storage (Bldg. 422)	UG
DF	0.55	1828	SAC Apron	UG
JP-4	50 (x 16)	1962	SAC Apron	UG
FO	3	2156	Ammo Storage	UG
FO	5	2155	Ammo Storage	UG
FO	1	2154	Ammo Storage	UG
FO	1	2151	Ammo Storage	UG
FO	3	2149	Ammo Storage	UG
FO	15	2148	SAC Alert	UG
FO	12+	2008	121	AG
FO	0.5	--	124	AG
FO	0.25	--	124	AG
FO	0.15	--		AG
FO	0.3	--	168	AG
DF	1.5 (x 2)	2163/2164	392	UG
FO	1,450	--	413	AG
FO	0.5(x 2)	--	413	AG
Misc	285	2001	425-426	UG
Waste Oil	1	2142	425-426	UG
MOGAS	5	2140	425-426	UG
Waste Oil	1	2141	425-426	UG
MOGAS	2	1968	445	UG
DF	0.8	1947	445	UG
FO	6	2146	445	UG
FO	5	--	445	UG

Table 4.1-1. POL Storage Tanks by Location (Continued, Page 2 of 3)

POL Type	Capacity (1000 gal)	Facility No.	Location/ Building No.	Tank Type
FO	0.4	--	445	UG
Lube Oil	2	2002	475	UG
DF	30 (x 3)	1957	475	UG
MOGAS	30 (x 2)	1957	475	UG
FO	0 .3	--	509	AG
FO	2	--	530	AG
FO	2.5	2058	531	UG
DF	5	2144	546	UG
FO	0.5	2117	546	UG
FO	2	--	546	UG
MOGAS	10 (x 2)	2104/2105	583/585	UG
Waste Oil	1	2106	583/585	UG
DF	1	2103	583/585	UG
MOGAS	10	2166	583/585	UG
FO	5	2157	583/585	UG
FO	0.25	--	718	--
MOGAS	0.25 (x 2)	--	765	AG
FO	0.25	--	768	AG
Solvent	0.45	--	837	--
Solvent	0.55	--	837	--
Solvent	0.5	--	837	--
FO	0.38	--	886	AG
MOGAS	10 (x 2)	2167/2123	891-893	UG
MOGAS	10	2122	891-893	UG
MOGAS	0.4	2160	891-893	UG
FO	0.1	--	891-893	AG
FO	3	2116	973-975	UG
FO	20	2118	973-975	UG
DF	4	2016	973-975	UG
JP-4	2	2074	995	UG
JP-4	2	2075	995	UG
MOGAS	2	2077	995	UG
Waste Oil	0.4	--	995	--
FO	7.4	--	999	UG
FO	0.55	2158	1016	UG
FO	0.55	2159	1019	UG
FO	0.3	--	1023	AG
FO	0.25	--	1032	AG
FO	0.25	--	1035	AG
FO	0.3	--	1041	UG
MOGAS	0.3	2161	1062	UG
FO	0.1	--	1071	--
FO	15	--	1085	UG
JP-4	0.6	--	1085	AG
MOGAS	0.6	--	1085	AG

Table 4.1-1. POL Storage Tanks by Location (Continued, Page 3 of 3)

POL Type	Capacity (1000 gal)	Facility No.	Location/ Building No.	Tank Type
FORTUNA AFS				
Fuel Oil	50 (x 4)		3	UG
Diesel	6		3	UG
Diesel	6		2	UG
Waste Oil	10		2	UG
MOGAS	1.5		F-54	UG

+ barrels (42 gal)
* drums (55 gal)

Fortuna AFS

Fuel oil used at the heating plant was stored in one of four 50,000 gal tanks. The plant shut down in 1983, and two of the four tanks is reported to contain residual fuel oil. The remaining two tanks were pumped and cleaned before closure.

JP-4 Storage and Disposal

JP-4 is stored primarily in tanks located at the POL Storage Area and the SAC Apron. JP-4 is transported from bulk storage to tanks on the flightline by means of service vehicles or UG transfer line. The service vehicles are dispatched from the controlled area near Building 420 to the flightline for refueling operations. The 10-in diameter JP-4 transfer line runs southwest from the POL storage area to the TAC Alert Taxiway, then northwest approximately one mile to the JP-4 storage tanks at the SAC Apron. Personnel from base fuels operate and maintain the fuel storage and distribution system. Storage tanks, valves and piping are inspected daily to check for conditions which pose a fire or spill hazard. Past spills which have occurred in the transfer of JP-4 to tanks and vehicles are discussed in detail in Section 4.2.3.

Waste POL Storage and Disposal

Waste POL at MAFB includes waste lubricating oil, petroleum based solvents, and synthetic oils. Table 4.1-2 is a list of lubricating oil, hydraulic fluids and petroleum based solvents which are considered recoverable petroleum products at MAFB. MAFB Regulation 19-1 outlines the procedure for collection, segregation and storage methods of the waste POL.

The Aircraft Fuels Systems and Repair Shop in Building 836 is the primary generator of "waste" JP-4 at MAFB. Inspections are performed by the shop on fuel systems in aircraft. If leaks are detected, the aircraft is defueled and JP-4 contained in fuel lines and other parts is drained into bowsers. Hydraulic fluids, water and other contaminants may be mixed with the fuel, which is generated at the rate of 150 to 200 gal/month. The POL Fuels Laboratory tests residual aircraft fuel for quality and determines its use. When tests indicate fuel is not usable in aircraft, support equipment or ground equipment, it is disposed of in the fire training tank (if it

Table 4.1-2. Recoverable Waste Petroleum Products Generation

Recoverable Waste	Source	Quantity (Gal/Yr)	Condition
Engine Oil	Internal Combustion Engines	20,200	Contaminated
Gear Oil	Vehicle Assemblies	400	Contaminated
Hydraulic Fluid	Vehicle Hydraulic Systems	2,000	Contaminated
Transmission Fluids	Transmissions	1,500	Contaminated
MIL-L-7808	Aircraft Engine Oil	840	Contaminated
MIL-H-5606	Hydraulic Fluid	1,000	Contaminated
JP-4	Aircraft Fuel	40,000	Contaminated

Source: MAFB Regulation 19-1, July 20, 1984.

contains less than 10 percent contamination) and used in fire training. Any fuel which contain more than 10 percent by volume of oil cannot be used in fire training and must be sold to a contractor through DPDO. A recent filtering process which can recycle the JP-4 for use in AGE equipment or fire training has substantially reduced the amount going to contractors.

Currently, all waste petroleum and synthetic based waste oil is sold to contractors. The new contract at DPDO with waste oil collectors specifies that waste oil must be segregated into drums; however, a few areas with AG oil tanks are still pumped out as part of the agreement. The drums are currently stored at Building 2017 on an unbermed concrete area, and separated into petroleum based and synthetic based groups. From October 1982 to September 1983, 7,878 gal of lubricating oil and 3,748 gal of synthetic oil were sold to contractors.

The waste oil tanks at the Hobby Shop (Building 583) and Service Station (Building 585) are pumped by the local contractor through an agreement not handled by DPDO. It is reported that all waste lubricating oils, hydraulic fluids and solvent (including PD-680) are put in these tanks for recycling.

Prior to 1984, UG tanks at the POL Storage area were used for all petroleum and synthetic based waste oil sold to contractors. These tanks were installed around 1972, to supplement the UG storage which existed at the motor pool area. Since 1984, use of the UG tanks at POL Storage has been terminated.

Prior to 1979, waste oil at Fortuna AFS was generated from vehicle maintenance and the service of diesel engines at the power plant. Base vehicles were serviced at the Auto Maintenance Shop (Building 30) and the Auto Hobby Shop (Building 55). Base personnel report that this oil was initially collected and used for roads for dust control. During the mid 1970's, contractors would pick up the oil for recycle. Waste oil from the service of diesel engines was placed in an UG storage tank near Building 2. Since 1979, only two government vehicles are serviced at the base. The oil is collected in 55-gal drums and hauled by MAFB.

4.1.3 PESTICIDE/HERBICIDE HANDLING AND STORAGE

Pesticides are applied to trees, shrubs, residential areas, building foundations and are used for mosquito control. Herbicides are routinely applied to roadways, open areas, the golf course, lagoon banks and around buildings. Soil sterilants are used at the missile sites along fence lines of secure areas. Both contractor and Roads and Grounds personnel have been utilized in the application of soil sterilants at the missile sites.

Pesticides and herbicides are stored in Building 445 and in an adjacent open storage area. Prior to 1977 pesticides were stored in an open area east of Building 124. Herbicides were stored in Building 551 in 1977 to 1984, in Building 510 in 1975 to 1977 and in Building 470 in 1969 to 1975.

Mixing operations are conducted at the storage locations. Empty containers are triple-rinsed and disposed of as solid waste with the rinse water used in subsequent mixing.

4.1.4 PCB HANDLING AND STORAGE

PCB transformers at MAFB are identified by nameplate inspection of in-service transformers or by PCB analyses of leaking or out-of-service transformers. If a transformer does not have a nameplate, or if there is no specific information available to indicate the type of dielectric fluid inside, the transformer is assumed to be a PCB-contaminated transformer (i.e., PCB concentration of 50-500 ppm). The base Bioenvironmental Engineer arranges to have the transformers sampled and tested to determine the classification of the unit. Once this is accomplished, the transformer is labeled as containing or not containing PCBs. The procedures for PCB handling, storage, disposal and spill prevention and control are presented in the MAFB Hazardous Waste Management Plan.

The Exterior Electric Shop in Building 470 currently stores and reworks transformers. The shop is responsible for maintaining all the high voltage on the base. Waste transformer oil is generated at approximately 500 gal/year and turned into DPDO for disposal. Currently, all PCB-contaminated materials are placed in Building 1016 prior to offsite disposal. Prior to the allocation of Building 1016 for storage, Building 471 (near the Electric

Shop) was used to store PCB materials awaiting shipment. Building 471 was lined and diked with sandbags for secondary spill containment. The building was recently dismantled and removed from MAFB. PCB- and PCB-contaminated transformer fluid removed from the base is disposed of in an EPA-approved incinerator, or placed into permanent storage until disposal occurs. PCB transformers are incinerated or flushed with solvent and buried in the EPA-approved landfill. All materials are sealed in EPA-approved containers before tranferral to Building 1016. No record was found of PCB spills or on-base disposal of transformer oil.

A PCB site investigation was conducted at Fortuna AFS in June of 1984. All oil-filled electrical equipment was inspected and tested. No equipment contained more than 500 ppm of PCB. Twelve inservice transformers were found to be PCB contaminated. MAFB services and/or replaced all transformers and electrical equipment at Fortuna. Recently, several soil samples were collected by MAFB personnel in PCB suspected areas, including an area where transformers were stored in the past. The results of these PCB analyses were all negative.

4.2 HAZARD WASTE GENERATION/DISPOSAL

4.2.1 GENERATING OPERATIONS

MAFB engineering personnel provided a Hazardous Waste Management Plan which contained a hazardous waste inventory. This listing was used to make a preliminary assessment of the types and quantities of waste generated by the various operations. Interviews were conducted with personnel from each of the major waste generation points. Telephone contacts were made with operations which generated comparatively smaller quantities of waste. In each interview, personnel were asked to verify or update the types and quantities of waste generated as reported in the inventory. By locating personnel who had long employment histories, information was obtained on how waste disposal practices had changed over the years. These interviews provided the information on disposal methods presented in Section 4.2.2.

Information obtained on the major waste generating operations is summarized in Table 4.2-1. The locations of numbered buildings referenced in Table 4.2-1 are shown on Figure 4.2-1. Not all the wastes listed are hazardous wastes

Table 4.2-1. Industrial Operations (Shops)--Waste Generation (Page 1 of 5)

Shop Name	Location (Bldg. No.)	Waste Material	Waste Quantity (gal/yr)*	Waste Management Practice 1960–1970	Waste Management Practice 1970–1980	Waste Management Practice 1980
I. 91st SMW						
A. 91st FMMS						
1. Shops Maintenance Branch						
a. Power Electric Refrigeration	546	Sodium Chromate	20 lbs/mo	NEUT./SS		CD
		Battery Acid	36	NEUT./SS	NEUT./SS	
		Lube Oil	40	FTA/DC	CD/DC	CD
b. Mechanical Shop	546	PD-680	20	FTA/LF/SS	CD/DC/SS	CD
2. Facility Maintenance Branch						
a. Periodic Maintenance Teams	Missile Sites	Motor oil-Diesel mix	1200	FTA/DC	CD/DC	CD
b. Preudralics Shop	546	Hydraulic Oil	120	FTA/DC	CD/DC	CD
		PD-680	15	FTA/LF/SS	CD/DC/SS	CD
		Greases	10	FTA/DC	CD/DC	CD
c. Corrosion Control	546	MEK	25	LF/SS/DC		CD
3. Vehicle/Equipment Control Branch	537	Separator Sludge	2500	FTA		CD
B. 91st Transportation Squadron						
1. Vehicle Maintenance Branch						
a. General Purpose 2	426	PD-680	90	FTA/LF/SS	CD/DC	CD
		Lube Oil	165	FTA/DC	CD/DC	CD
		Synthetic Oils	200	FTA/DC	CD/DC	CD
		Aromatic Cleaning Solvents	165	LF/SS/DC		CD
		Carbon Remover	15	LF/SS/DC		CD
b. Heavy Equipment	425	PD-680	65	FTA/LF/SS	CD/DC	CD
		Syhthetic Oils	330	FTA/DC	CD/DC	CD
		Alcohols	330	LF		CD
		Lube Oils	50 lbs/yr	FTA/DC	CD/DC	CD
		Chlorinated Solvents	40	LF/SS/DC		CD
c. POL Maintenance	457	PD-680	60	FTA/LF/SS	CD/DC/SS	CD
		JP-4	60	FTA	CD	R
		Lube Oils	45	FTA/DC	CD/DC	CD

Table 4.2-1. Industrial Operations (Shops)--Waste Generation (Page 2 of 5)

Shop Name	Location (Bldg. No.)	Waste Material	Waste Quantity (gal/yr)*	Waste Management Practice 1960 – 1970 – 1980
d. General Purpose	425	Aircraft Soap	1000	SS
		Lube Oils	165	FTA/DC | CD/DC | CD
		Chlorinated Solvents	72	LF/SS/DC | CD
		PD-680	110	FTA/LF/SS | CD/DC/SS CD
		Transmission Fluid	150	FTA/DC | CD/DC | CD
e. Diagnostic/QC	460	Lube Oils	variable	FTA/DC | CD/DC CD
		Sulfuric Acid	variable	NEUT./SS | NEUT./SS
C. 91st Supply Squadron				
1. Fuels Management Branch				
a. Fuels Control Center	420	Lube Oils	20	LF/DC | CD/DC | CD
		Aircraft Cleaning Soap	600	SS
II. 5th BMW				
A. 5th FMS				
1. AGE Branch	995	PD-680	600	FTA/LF/DC | CD/DC/SS | R/CD
		Lube Oils	600	FTA/DC | DC/CD | CD
		Washrack Detergents	variable	SS | TANK
		Hydraulic Fluids	variable	FTA/DC | DC/CD | CD
2. Aerospace Systems Branch				
a. Hydraulic Shop	857	PD-680	420	FTA/LF/DC | DC/CD | CD
		Hydraulic Fluid	180	FTA/DC | CD
b. Aircraft Fuels Systems	836	JP-4	1800	FTA | FTA/CD | R
c. Aircraft Repair and Reclamation Shop	857	PD-680	1200	FTA/LF/SS | DC/CD | CD
d. Wheel and Tire Shop	Dock 3	Aircraft Soap	1200	SS | SS
		PD-680	300	FTA/LF/SS | DC/CD | CD | R
		Oil Sludges	5	SHOP-SITE GROUND EVAPORATION
e. Electric Shop	857	Battery Acid	600	NEUT/SS | NEUT/SS
		Turbine Oil	100	FTA/DC | CD/DC | CD

Table 4.2-1. Industrial Operations (Shops)--Waste Generation (Page 3 of 5)

Shop Name	Location (Bldg. No.)	Waste Material	Waste Quantity (gal/yr)*	Waste Management Practice (1960–1980)
3. Fabrication Branch				
a. Corrosion Control	837	PD-680	variable	FTA/LF/SS | CD/DC | CD
		Combined Paint and Stripper	1500	SS | TANK
b. Machine Shop	837	Cutting Oils	10	EVAP | EVAP
c. Structural Repair	837	MEK	12	LF | CD
d. Non-destructive Testing Shop	857	1,1,1-trichloro-ethane	100	LF | CD
		silver	variable	R | R
4. Propulsion Branch				
a. Jet Engine Conditioning	748	Turbine Oil	55	FTA/DC | CD/DC | CD
		methanol	15	FTA/DC/ | CD/DC | CD
b. Test Cell	973	Hydraulic Fluid	60	FTA/DC | CD/DC | CD
B. 5th OMS				
1. Mission Support Branch	869	Alkaline Cleaner	60	SS | TANK
		PD-680	15	SS | TANK
		Lube Oils	60	FTA/DC | CD/DC | CD
2. Bomber Branch	867	Paint	variable	SS/LF | TANK/CD
		PD-680	210	SS/LF | TANK/CD
		Aircraft Soap	2400	SS | TANK
		Lube Oils	variable	FTA/DC | CD/DC | CD
3. Tanker Branch	862	Paint	variable	SS/LF | TANK/CD
		Lube Oils	variable	FTA/DC | CD/DC | CD
4. Alert Branch	1085	Lube Oils	20	FTA/DC | CD/DC | CD
C. 5th AMS				
1. Flight Control Branch				
a. Instrument Shop	859	Lube oils	10	FTA/DC | CD/DC | CD
2. Mission Systems Branch				
a. Fire Control Shop	859	PD-680	40	FTA/LF | CD/DC | CD
D. 5th MMS				
1. SPAM Maintenance Branch	1113	Non-chlorinated Solvents	70	FTA/LF/SS | CD
2. Munitions Services Branch	975	Mineral spirits	45	FTA/LF | CD

Table 4.2-1. Industrial Operations (Shops)--Waste Generation (Page 4 of 5)

Shop Name	Location (Bldg. No.)	Waste Material	Waste Quantity (gal/yr)*	Waste Management Practice		
				1960	1970	1980
III. 5th FIS						
1. Aircraft Generation Branch						
a. Weapons Load	766	PD-680	36	FTA/LF/SS	CD/DC/SS	CD
b. Support Equipment	765					
2. Missile Maintenance Branch	879	Stripper	20		LF	CD
		1,1,1-trichloroethane	12		LF	CD
3. Field Maintenance Branch						
a. Corrosion Control	763	MEK	65	LF/SS/DC		CD
		Laquers, thinners	65	LF/SS/DC		CD
		Toluene	65	LF/SS/DC		CD
		Polyurethane Enamel Paints	variable	LF/SS/DC		CD
		isopropyl alcohol	15	LF/SS/DC		CD
b. Pneudraulics Shop	766	PD-680	30	FTA/LF/SS	CD/DC/SS	CD
		1,1,1-trichloroethane	500	LF/SS		CD
c. Aircraft Repair	758	Lube Oils	20	FTA/DC	CD/DC	CD
		PD-680	10	FTA/LF/SS	CD/DC/SS	CD
d. AGE	765	PD-680	100	FTA/LF/SS	CD/DC/SS	CD
		Aircraft Soap	240		SS	
		Lube Oils	8	FTA/DC	CD/DC	CD
4. Inspection Section	763	PD-680	8		CD/DC/SS	CD
IV. 91st CSG						
A. 91st CES						
1. Paint Shop	445	Naptha	1000	LF/DC	CD/DC	R
2. Exterior Electric	470	Transformer Oil	550		DC/CD	CD
3. Liquid Fuels	445	Tank Cleaning Sludges	variable	WEATHERED IN PITS		CD
4. Environmental Support	994	Sodium Hydroxide	1600 lb/mon	NEUT/SS	NEUT/SS	
		Hydrochloric Acid	6700 lb/mon	NEUT/SS	NEUT/SS	

Table 4.2-1. Industrial Operations (Shops)--Waste Generation (Page 5 of 5)

Shop Name	Location (Bldg. No.)	Waste Material	Waste Quantity (gal/yr)*	Waste Management Practice 1960	1970	1980
B. 91st Headquarters Squadron						
1. Recreation Division						
a. Firing Range	20188	PD-680	20	DC/LF		CD
		Rifle bore cleaner	10	DC/LF		CD
b. Hobby Shop	383	Lube Oils	1200	FTA/DC	CD/DC	CD
		PD-680	660	FTA/DC	CD/DC	CD
V. Det. 7, 37th ARRS		Lube Oils	variable	FTA/DC	DC/CD	CD
VI. Fortuna Radar Site						
1. Vehicle Maintenance	30	Lube Oils	330		DC	CD
2. Hobby Shop	55	Lube Oils	variable		DC	CD
3. Power Plant	38	Lube Oils	variable		DC	CD

* All quantities expressed in gal/yr unless noted.

____________ Data confirmed by Shop Personnel.

\- - - - - - - - Estimated from Secondary Sources.

FTA - Firefighter Training Area.

CD - Contract Disposal via DPDO or Service Contract for Recycling.

Tank - Held in underground Holding Tank pending Contract Disposal.

NEUT - Neutralized.

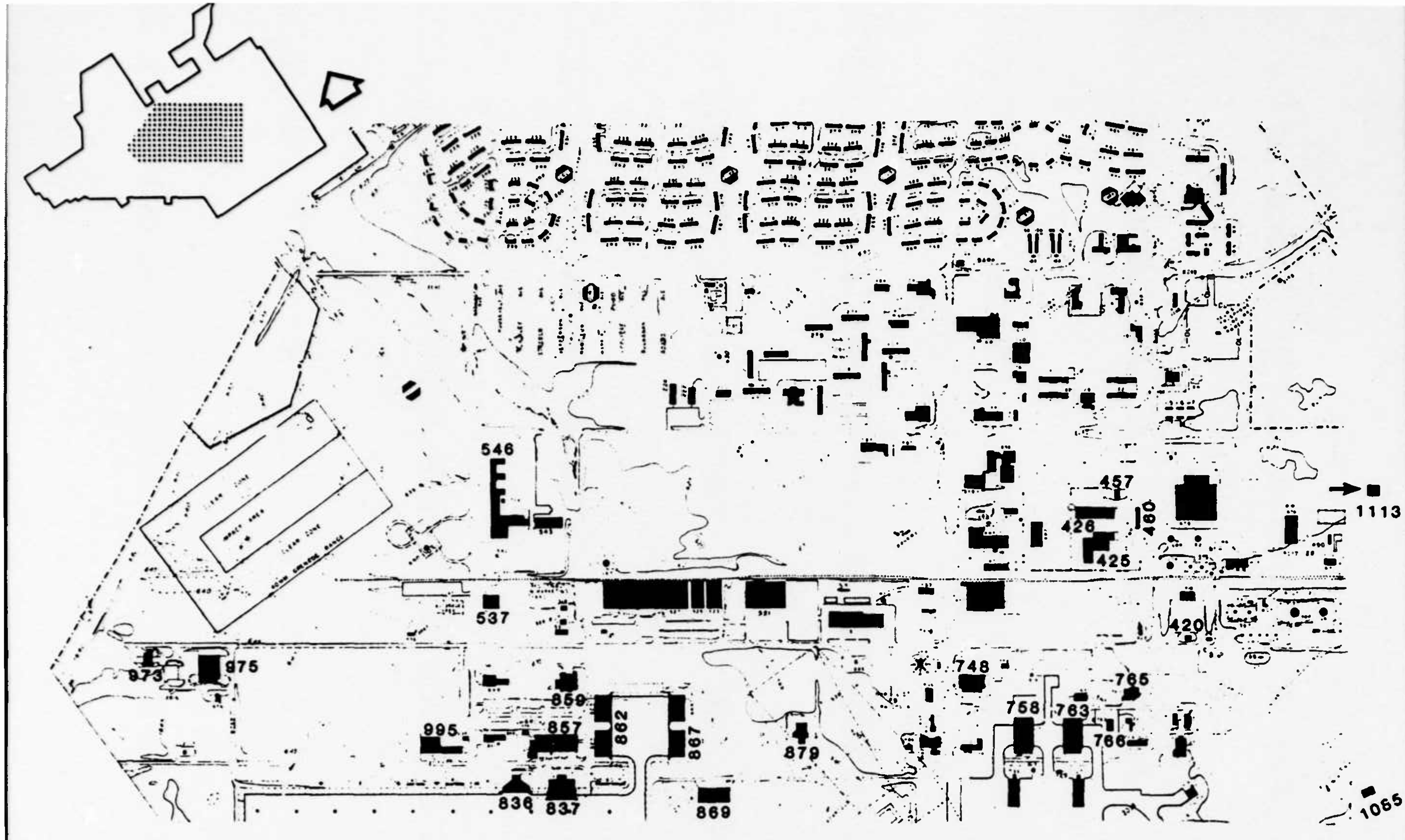
R - Recycled/Reclaimed.

DC - Used in dust control.

EVAP - In-process evaporation.

SS - Sanitary Sewer.

LF - Landfill - Buried in/on Base Landfill.



SOURCE: MAFB INSTALLATION DOCUMENTS

as defined by the EPA, but have been included to provide a complete picture of the range and quantity of waste generated which require controlled disposal. A master list of facilities and shops at MAFB and their waste generation status is presented in Appendix D.

The main types of wastes generated at MAFB are fuel, oil and solvents, paint and paint strippers, and associated sludges. Waste fuel, oil and solvents include JP-4, engine oil, PD-680 and battery acid, which are derived from periodic maintenance and engine repair operations. Waste consisting of paint residue, strippers and thinners are generated primarily from the 5th BMW Corrosion Control and CES Paint Shops. Other corrosion control shops perform touch-up work only and generate much smaller quantities of waste.

4.2.2 DISPOSAL METHODS

The information obtained on waste disposal practices is summarized in Table 4.2-1. The general trend over the years since MAFB began operation has been from largely unsegregated disposal in base landfills and sanitary sewers toward extensive waste segregation and contract disposal.

The base landfill, located adjacent to the sewage lagoons on the northwest corner of the base, was utilized from the initiation of base operations until 1982 for the disposal of sanitary and other wastes. The landfill was operated under North Dakota Permit for Solid Waste Disposal Operation Permit No. SW-247. Conditions of the permit allowed disposal of garbage, construction wastes, and brush and tree trimmings. Since 1982 sanitary waste has been hauled to an offbase disposal site by a contractor. While authorized disposal at the landfill is currently restricted to construction rubble, there is evidence of unauthorized dumping of other materials, such as household furnishings, scrap wood, empty pesticide containers, and empty drums.

An old trench in the landfill has begun to fill with rainwater, snow melt and leachate percolating from the base sanitary landfill. Vigorous methane generation was observed in this trench. The leachate contains heavy metals and phenols and may have originated from garbage and/or hazardous waste

placed in the landfill. MAFB has installed four monitoring wells at this site (see Figure 4.3-2).

Two pits in the landfill area were used from 1977 to 1980 for the disposal of sludge from tank cleanings. They are located 100 ft northeast of the small arms range, and encompasses an area of approximately 400 square feet (ft^2) each. Sludge deposited in this area may have infiltrated into the underlying surface.

Prior to 1973, the Heating Plant was coal-fired. The ash from this plant was reported to have been disposed of in the base landfill. Since 1973, the plant has used natural gas as the primary fuel with fuel oil as backup.

By the early 1960's, the fire training area served as the contaminated fuel and lubricant disposal point. JP-4 was the primary fuel used in fire training; however, it is reported that other fuels such as MOGAS were mixed with the JP-4 for burning. The burn pit was equipped with a drainage line which allowed anything poured into the pit to flow into a drainage ditch. At present drainage from the pit flows to an oil separator which is periodically pumped.

Contaminated oils (including synthetic oils, motor oils, solvents, and other industrial wastes) were disposed into an oil lagoon located near the fire training pit. Over the years, this disposal point became very oil-soaked. Test borings to a 4 ft depth performed in 1971 showed only a slight decrease in contaminant concentration. This lagoon is discussed in detail in Section 4.3. Another source of the POL disposal in the early 1960's was for road stabilization by the city of Minot. The oils were reportedly stored at the motor pool area until off-site transport. Wastes used for dust control were largely unsegregated industrial liquids, such as solvents and waste oils.

From the time of base startup until about 1978, the dielectric fluid from the transformers (PCB and non-PCB) were reported to be drained from the casings prior to transfer to DPDO. The ultimate disposal of these fluids is difficult to substantiate, but it is likely they were included with other waste oils and disposed accordingly. Waste sodium chromate was neutralized

and sent to the sewer. Other solid and liquid hazardous wastes not included with waste POL were reported sent to the landfill or the sewer.

Waste disposal practices at MAFB changed substantially in the early 1970's. The segregation of waste petroleum oils, synthetic oils and JP-4 began with the installation of three UG tanks at the POL Storage area. The waste oils and fuels were pumped from these tanks by outside contractors and recycled. Liquid Fuels obtained a pump truck which was used to pump oil from bowsers for on-base road stabilization. Programs were initiated to halt the disposal of waste oils in lagoons, except for the "weathering" of sludges from tank cleanings.

In 1971, a work request was made for the installation of oil separators in the storm sewer. The separators were installed behind the PRIDE Building in the "A" ditch (where extensive vehicle washing was performed) and 100 ft downstream of the fire training pit in the drainage ditch. Prior to 1971, the storm sewer was not equipped with oil separators. In addition, oil separators for washracks and kitchen grease separators had not been installed. The waste from these areas was discharged directly to the sewers.

In 1978, MAFB began to implement widespread segregation of industrial wastes. A survey conducted at MAFB in 1980 identified hazardous waste generators and quantities. The wastes were drummed and hauled to a bermed, non-conforming hazardous waste storage area located at the south end of the landfill.

By 1982, approximately 215 drums of hazardous waste had accumulated in the hazardous waste storage area, with an additional 160 drums in the custody of DPDO. At this time, an existing unused transmitter building (Building 1019) was altered for conforming storage. PCB waste storage was moved from Building 471 to Building 1016, which serves as the current PCB waste storage building. By late 1982, Fuels Management was assigned the task of cleaning up the earthen hazardous storage site, which had several overturned and leaking drums. Subsequent analyses indicate that this storage area was not

contaminated by the materials in storage. Shortly thereafter, a contractor began hauling the drums to a hazardous waste management facility.

A new hazardous waste storage building (Building 532) is scheduled to replace Building 1019 by late 1984. The new facility is expected to increase present storage capacity from 216 drums to 360 drums. Hazardous waste accumulation points have been designated at MAFB to centralize the waste collected for transfer to Building 532. Each accumulation point has an appointed manager responsible for logging in the type and quantity of waste left at the accumulation point. No hazardous wastes are received at MAFB from off-site generators.

The waste oil previously put in the tanks at the POL Storage area is now drummed according to the new contractual requirements. Synthetic oils and petroleum based oils are segregated in 55 gal drums and stored on an outside concrete pad at Building 2017. A few AG tanks are still being pumped as specified in the DPDO contract.

A recent process which allows contaminated JP-4 to be reclaimed for AGE equipment has almost eliminated the need for outside contract disposal. The recycled fuel is sold to AGE and the Fire Department as a new fuel.

The EOD Range is used to burn or explode unserviceable munitions, starter cartridges, flares, impulse cartridges, explosive bolts, and explosives. Such operations are conducted approximately once each month. Fourteen pits at the EOD Range have been used to bury used starter cartridges. The cartridges are certified to be empty prior to burial. The largest of the pits is 10 ft deep and measures 30 ft by 30 ft on the surface.

4.2.3 SPILLS OR INCIDENTAL DISCHARGES

Following is a list of spill incidents or incidental discharges involving more than 1,000 gal that have occurred at MAFB and related properties:

1. February 25, 1977, a spill involving 2,700 gal of JP-4 occurred at the bulk storage area during an offloading operation of a railroad

car. The JP-4 was contained inside the diked area where it evaporated and caused minimal environmental damage.

2. August 21, 1979, a malfunctioning internal fuel pipe in a KC-135 resulted in a 1,050 gal JP-4 spill at the SAC Tanker Alert Pad. The fuel was washed down by the Fire Department into a storm drainage ditch where it was contained by a dike from entering natural waterways. There it evaporated and caused moderate environmental damage.

3. A reported eleven spills have occurred which resulted in the release of less than 1,000 gal, nine of which involved JP-4. Of these JP-4 spills, only one spill (500 gal) entered the base storm sewer system. The remaining 8 spills were confined to the SAC Apron area or within the dikes at the POL Storage Area. Each of these spills were reported to have caused minimal environmental damage.

Two spills involving diesel fuel have occurred at missile sites at MAFB. An undetermined amount of fuel was released at missile site F-6 when a fill pipe was sheared during snow removal operations. At missile site D-1, a plumbing mistake resulted in a 900 gal diesel spill, which affected approximately 0.1 acres. Neither of these spills resulted in major environmental damage.

4.2.4 OFFBASE DISPOSAL SITES

Available information indicates that materials originating at MAFB are currently directed to eight disposal site. Solid waste is transported to a local landfill through a local contract. Hazardous and liquid wastes are disposed of through arrangement with the Aqua-Tech, Inc. in Wisconsin. PCB waste is hauled to Ensco in Arkansas for incineration. Hazardous waste and PCB disposal contracts are handled through the DPDS in Battle Creek, Michigan. DPDO has a local contract with Northwest Rendering for the disposal of bone and fat from on-base kitchens. Grease separators are pumped out by another contractor through CES. The waste synthetic oil is currently sold to Ron Lanson in Lake Crystal, Minnesota. Petroleum based oil is sold to Tri-B Oil in Minot. Both of these contracts are handled by

the DPDO. Waste oils from the Hobby Shop and base service station is taken by another local contractor for recycling.

4.3 AREAS OF POTENTIAL CONTAMINATION

The review of past operation and maintenance functions and waste management practices at MAFB and its subinstallations identified several sites of potential contamination. Each of these areas was evaluated by examining pertinent documents, and in most cases by site visits. The potential for contamination, potential for contaminant migration, and potential for other environmental concerns were assessed. These sites, described below, were evaluated using the decision process presented in Figure 1.3-1. Results of this evaluation are summarized in Table 4.3-1.

Most of the sites of potential contamination are of little concern. Site visits and review of existing records indicated that adequate cleanup and/or maintenance procedures have been implemented as in the case of fuel spills, the dump site at Fortuna, and the small arms range at MAFB. Three of the areas were determined to present a potential hazard to health, welfare, and/or the environment and were further evaluated using the HARM system. These sites were the Landfill, Firefighter Training Area, and EOD Range. Figures 4.3-1 and 4.3-2 show the location of these areas of concern.

Landfill

The base landfill, located adjacent to the sewage lagoons on the northwest corner of the base, was utilized from the initiation of base operations until 1982 for the disposal of domestic and other wastes, including POL and a variety of potentially hazardous wastes. Authorized disposal at the landfill is currently restricted to construction rubble, although there is evidence of unauthorized dumping of other materials, such as household furnishings, scrap wood, empty pesticide containers, and empty drums.

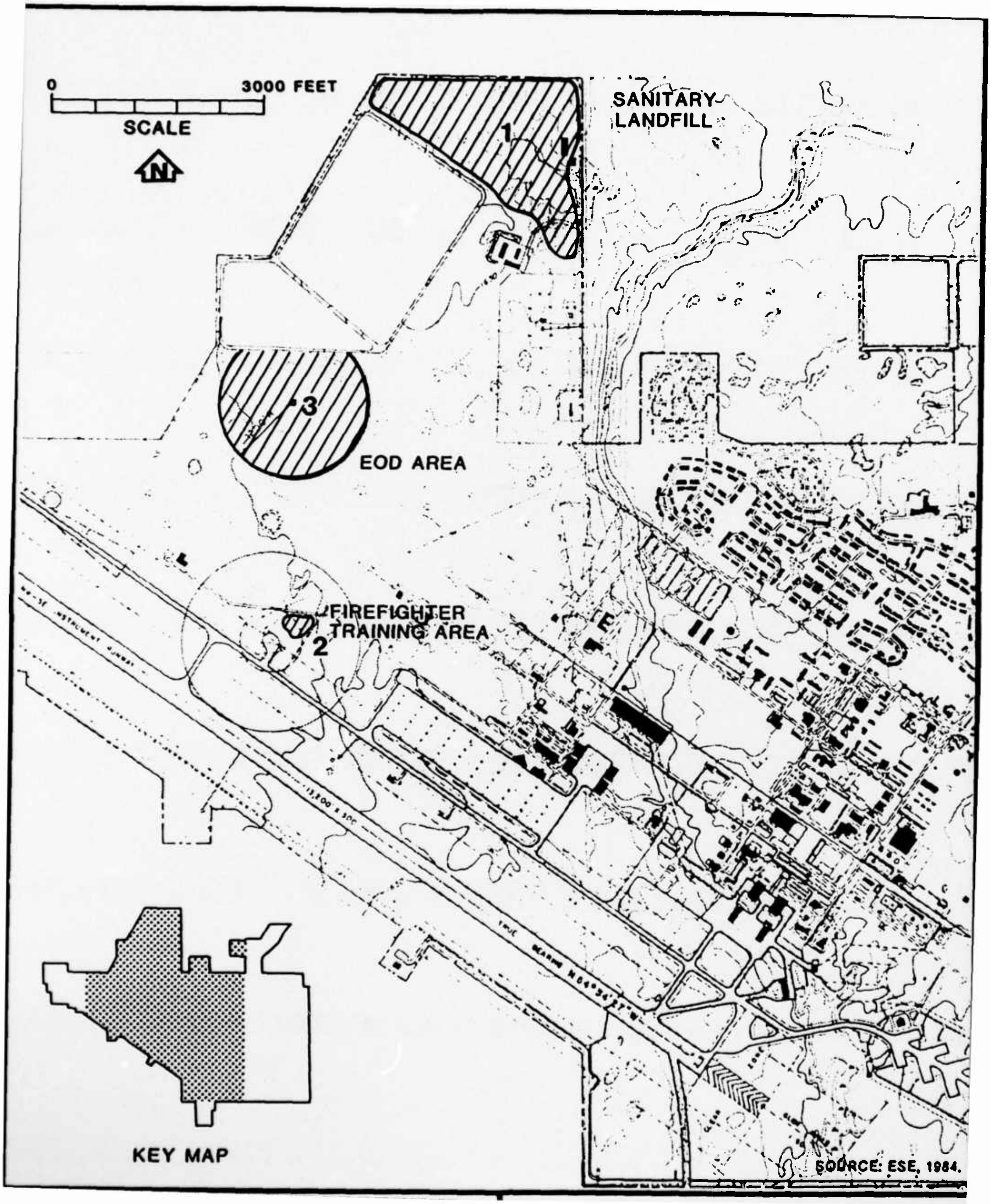
An old trench in the landfill has begun to fill with rainwater, snow melt and leachate percolating from the base sanitary landfill. Vigorous methane generation was observed in this trench. The leachate contains metals and phenols and may have originated from garbage and/or hazardous waste placed in the landfill. MAFB has installed four monitoring wells at this site.

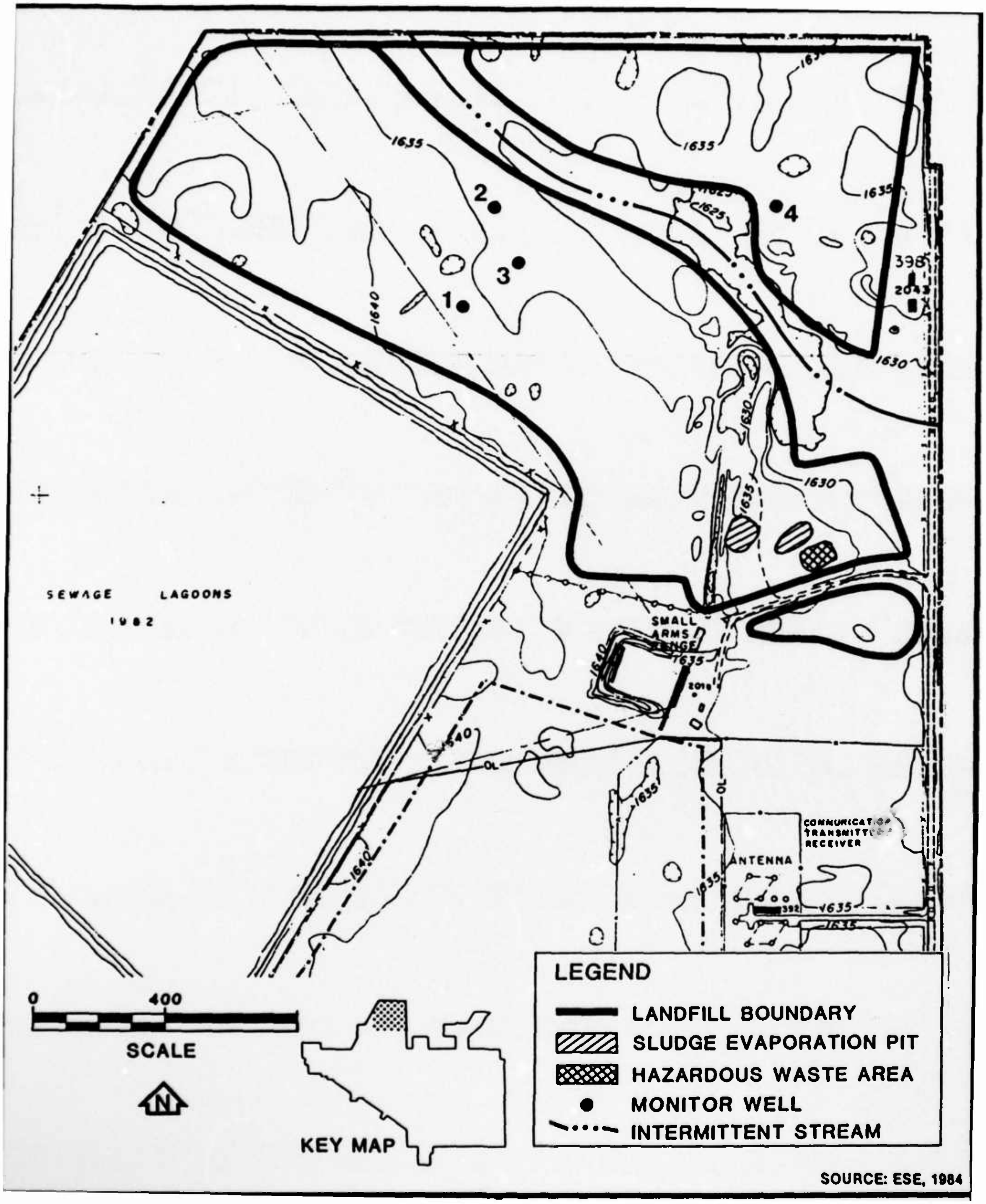
Table 4.3-1. Summary of Decision Process for Areas of Initial Environmental Concern at MAFB

Site Description	Potential for Contamination	Potential for Contaminant Migration	Potential for Other Environmental Concern*	HARM Rating
Landfill	Yes	Yes	Yes	Yes
Firefighter Training Area	Yes	Yes	Yes	Yes
EOD Area	Yes	Yes	Yes	Yes
Small Arms Range	Yes	Yes	Yes	No
Fuel Spill Site No. 1	Yes	No	No	No
Fuel Spill Site No. 2	Yes	No	No	No
Small Fuel Spill Sites	Yes	No	No	No
Storm Drain Discharge	No	No	No	No
Fortuna Dump Site	Yes	No	No	No

* Other environmental concerns include problems that are not within the scope of this study (e.g. air pollution, occupational safety requirements, etc.).

Source: ESE, 1984


0
3000 FEET
SCALE
N
SANITARY
LANDFILL
1
3
EOD AREA
FIREFIGHTER
TRAINING AREA
2
KEY MAP
SOURCE: ESE, 1984.



SOURCE: ESE, 1984

Firefighter Training Area

The Fire Protection Branch (DEF) training area served as a contaminated fuel and lubricant disposal point for many years. The old burn pit was equipped with a drain line which allowed liquids poured into the pit to enter a nearby drainage ditch. Fuels entering the ditch soaked into the ditch bottom or were transported off-base by runoff. Located near the burn pit were oil lagoons used as contaminated fuel and lubricant disposal points. The area was used for oil disposal from early 1960 to around 1972, when the UG tanks at POL storage were installed. Approximately 2,000 gal of JP-4 are currently burned each month in training operations.

Explosive Ordnance Disposal (EOD) Range

The EOD Range is used to burn, explode, and bury unserviceable munitions, starter cartridges, flares, impulse cartridges, explosive bolts, and explosives. Such operations are conducted approximately once each month. Heavy metal and PCP contamination are possible in portion of the range.

Small Arms Range

An earthen berm at the small arms ranges captures lead from rounds which are expended in training. The berm receives periodic maintenance which includes the removal and proper disposal of lead accummulations. Lead entrapped in the berm remains localized and does not migrate. Brass shells at the range are collected and recycled through DPDO.

Fuel Spill No. 1

A fuel spill involving 2,700 gal of JP-4 occurred at the bulk storage area during the offloading of a railroad car in February 1977. The fuel was contained in a diked areas where it evaporated, causing minimal environmental damage.

Fuel Spill No. 2

A malfunctioning internal fuel pipe in KC-135 resulted in a 1,050 gal JP-4 spill at the SAC Tanker Alert Pad in August 1979. The fuel was washed into a storm drain where it was contained by a dike and evaporated, causing minimal environmental damage.

Small Fuel Spill Sites

Eleven spills of less than 1,000 gal each have been reported. None of these spills resulted in migration of materials to locations which resulted in evnvironmental damage.

Storm Drain Discharge

Although the storm drain discharge system is a potential vehicle for migration of contaminants, the present system at MAFB incorporates adequate safeguards against the migration of contaminants. Oil separators have been installed at strategic locations in the sewer system, and adequate handling, storage, and disposal practices for other hazardous materials provide safeguards which prevent contaminant migration from MAFB.

Fortuna Dump Site

The dump site located at the Fortuna AFS was considered a potential area of contamination because of the potential for hazardous waste disposal within the area prior to the 1970's when adequate controls were implemented. Chemical testing at the site has not revealed contamination, and records do not indicate a high potential for contaminant presence or migration.

4.4 HAZARD ASSESSMENT

Three areas of potential contamination were determined to require rating with the HARM system, based on the decision tree presented in Figure 1.3-1. The Landfill, Firefighter Training Area, and EOD Area were the the sites selected for evaluation (Figure 4.2-2). Other areas of hazardous waste storage were eliminated from further consideration due to lack of evidence for potential contamination and migration.

Each of the sites discussed in Section 4.3 was rated using HARM methodology. HARM scores for each site are summarized in Table 4.4-1. The process of rating potential hazards using the HARM system is described in detail in Appendix F. Basically the method uses numerical ratings for a number of discrete variables in order to calculate subscores for three categories: (1) risk of human exposure (Receptors), (2) the nature and quantity of waste (Waste Characteristics), and (3) the potential migration routes (Pathways).

Table 4.4-1. Summary of HARM Scores

Rank	Site	Receptors Subscore	Waste Characteristics Subscore	Pathways Subscore	Waste Management Factor	Total Score
1.	Sanitary Landfill	45	48	100	0.95	61
2.	Firefighter Training Area	42	48	58	0.95	47
3.	EOD Area	42	15	58	1.0	38

Evaluation of some variables within the Receptor subscore required some judgement in using the available information. In particular, the distance to the nearest well and the population served by the ground water in the vicinity could not be established with certainty. Instead of deleting this critical factor from the subscore calculation, guidence provided in the National Oil and Hazardous Substances Contingency Plan (40 CFR 300) for use of the EPA Hazard Ranking System (HRS) was applied since this system was the basis for HARM. Specifically, occupied dwellings which are not within the service area of any public water supply and which had no other reported water source were assumed to have a private well. Populations were estimated by map inspection, ground tours of the surrounding area, and from aerial surveys. An average of 4 persons per household was assumed.

Waste characteristics were evaluated based on information obtained in interviews with base personnel. In instances where the waste was a mixture of substances with differing characteristics, the most critical waste was used for each variable. For example, a mixture of metal treatment sludges and waste solvents might be treated high for flammability due to the solvents and high for persistence because of the metal component in the sludge.

For the Pathway subscore, environmental factors such as rainfall intensity and net precipitation were evaluated using standard references such as the Climatic Atlas of the United States (USDC, 1979). Erosion potential was based on direct observation and soil charactersitics for the region (USSCS, 1974). Depth to groundwater was based on available boring logs, geologic data and interviews.

The three subscores are averaged to produce a final score for each site. This score is then multiplied by a factor to account for waste management practices to provide the final site rating score. HARM provides only three choices, 1.0, 0.95, and 0.1 to indicate no containment, limited containment, and fully contained and in compliance.

5.0 CONCLUSIONS

The goal of the IRP Phase I study is to identify sites where there is potential for environmental contamination resulting from past waste disposal practices and to assess the probability of contaminant migration from these sites. The conclusions are based on the assessment of the information collected from the Project Team's field inspection; review of records and files; review of the environmental setting; and interviews with base personnel, past employees, and state and local government employees.

All potential areas of concern were evaluated using the decision process contained in the IRP Record Search Format presented in Section 1. The areas and/or categories of potential concern included the landfill, firefighter training area, EOD range, small arms range, 2 fuel spill sites, the storm drain discharge, and the Fortuna dump site. Three of these sites were identified as having contamination and potential for contaminant migration and were evaluated using the HARM system.

Sanitary Landfill

The base landfill, located adjacent to the northwest sewage lagoons, was utilized from the initiation of MAFB in the late 1950s. Disposal of domestic waste ceased in 1982, but prior to that date a variety of materials, some potentially hazardous, were dumped in the landfill. Evidence of groundwater contamination based on monitoring wells drilled in the landfill area indicate a strong potential for contaminant migration. Two pits within the landfill area were used for the disposal of sludge from tank cleanings from 1977-80. The HARM score for this site is 61.

Firefighter Training Area

This area served as a contaminated fuel and lubricant disposal point for many years. The old burn pit was equipped with a drain line which directed liquids from the pit into a nearby drainage ditch. Fuels entering the ditch soaked through the soil and were transported via runoff from the base. Contaminated oils were disposed into an oil lagoon located near the fire training pit, leaving soil beneath the lagoon very contaminated. The HARM score for this site is 47.

EOD Range

The range is used to burn or explode unservicible munitions, starter cartridges, flares, and other small explosive devices. Used starter cartridges are also buried within the area. A potential for metal contamination and eventual migration exists. The HARM score for this site is 38.

6.0 RECOMMENDATIONS

The information gathered through interviews and research were sufficient to locate and categorize the onbase disposal sites. A Phase II monitoring program is recommended to accomplish the following objectives:

1. Obtain information regarding aquifer characteristics below MAFB. Such information would include stratigraphy, direction of ground water flow, and permeability.
2. Determine the nature and extent of surface water, ground water, soil, and sediment contamination that might have resulted from past storage, handling, and disposal practices.

In addition, recommendations are made regarding facilities and procedures currently utilized in the handling, storage, and disposal of hazardous materials.

6.1 PHASE II MONITORING RECOMMENDATIONS

The following actions are recommended to further assess the potential for environmental contamination from waste disposal areas at MAFB. The recommended actions are intended to be used as a general guide in the development and implementation of the Phase II study. The recommendations include the approximate number of ground water monitoring wells, type(s) of samples to be collected (e.g., soil, water, sediment) and suspected contaminants for which analyses should be performed. The number of ground water monitoring wells recommended corresponds to the number of wells required to adequately determine whether contaminants are migrating from a given source. The final number of ground water monitoring wells required to determine the extent of and define the movement of contaminants from each site will be determined as part of the Phase II investigation.

Recommended ground water monitoring should be performed periodically in order to assess contaminant migration under different variable hydrologic regimes. After 1 year of monitoring, the data should be evaluated to determine the need for further action (if any). All drilling activities should be conducted by a North Dakota-licensed water well driller. All monitor wells should be constructed of threaded-joint casing and factory-

AD-A154 712 INSTALLATION RESTORATION PROGRAM PHASE I: RECORDS SEARCH MINOT AIR FORCE..(U) ENVIRONMENTAL SCIENCE AND ENGINEERING INC DENVER CO J B SOSEBEE ET AL. DEC 84 2/2

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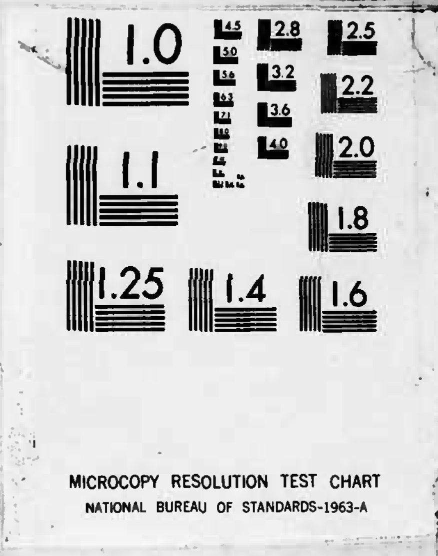
1.0
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

slotted screen. Under no circumstances should polyvinyl chloride (PVC) primer or PVC glue be used for the construction of well casing or bailers. Multi-level well clusters should be installed over the entire saturated interval of glacially deposited materials. The uppermost wells should be installed in the first water-bearing unit encountered and extend approximately 1 ft above the water table. These wells need to be screened above the water table to detect non-miscible, floating contaminants, such as petroleum products. Additional monitoring wells in each cluster should be designed according to data obtained during soil sampling and borehole logging. At a minimum, an additional well should be installed at a depth below the shallow monitor well, extending to the top of bedrock. Each well cluster should be completed with appropriate bentonite seals such that samples taken from wells within each cluster represent unique water bearing units. This will facilitate in determining the potential for vertical stratification of possible ground water contaminants. During drilling, Shelby tube samples should be taken to provide soils data and vertical permeability measurements. Borehole geophysical logging of all MAFB wells is recommended to facilitate stratigraphic analysis. The top of the filter pack should be bentonite-sealed, and the annulus should be grouted to the surface. The well should be protected with pipe fitted with locking caps. The well should be developed to the fullest extent possible and surveyed both vertically and horizontally by a registered surveyor to obtain accurate well location distances and water level elevations. Water levels should be measured after recovery from well development and at the time of sampling. At a minimum, slug tests should be conducted to determine horizontal permeability and to provide data for evaluation of flow rates.

Prior to initiation of any Phase II field activities, a detailed work plan should be prepared. This work plan should provide specific procedures to be followed in well construction, well logging, well installation, well development, surveying, water level measurements, aquifer testing, sampling, laboratory analysis, quality control, and reporting. All samples from the landfill area should be analyzed at a minimum for total petroleum hydrocarbons, halogenated and nonhalogenated solvents, metals, PCBs, and pesticides, using EPA-approved procedures. The solvent analytes should include at a minimum trichloroethylene (TCE), benzene, methyl isobutyl

ketone, carbon tetrachloride, MEK, methylene chloride, and acetone. The metal analytes should include cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. The Firefighter Training Area samples should be analyzed for total petroleum hydrocarbons, solvents, PCBs and metals. EOD area samples should be analyzed for metals. The recommended parameters include those compounds known or suspected to have been placed in the disposal sites. Certain additional parameters for which drinking water standards exist are included. It is recommended that chemical analysis for metals include both total and dissolved fractions to quantify which metals are mobile, as well as the total amount of metal sorbed onto suspended materials and, hence, potentially available for leaching. Because the oil and grease analysis by EPA Method 413.2 does not differentiate between extractables of biological origin or the mineral oils and greases of POL origin, the EPA Infrared (IR) Spectrophotometric Method for total recoverable petroleum hydrocarbons (EPA Method 418.1) is recommended for assessing POL contamination. Halogenated and nonhalogenated solvents, PCBs, and pesticides may be analyzed by EPA Methods 624 and 625 or comparable methods. All water samples should be analyzed for pH, temperature, conductivity, and oxidation-reduction potential at the time of sampling.

For the EOD Range and the Firefighter Training Area, it is recommended that four monitoring well clusters be installed around each of the sites 90 degrees from each other with respect to the center of the sites.

It is also recommended that a composite soil sample be obtained from the upper 3 ft of soil in the Firefighter Training and EOD sites. These samples will be used to evaluate the potential hazard posed by near surface soil contamination.

In the vicinity of the MAFB landfill, it is recommended that six monitor well clusters be installed. At a minimum, a shallow and deep monitor well should be completed at each cluster site. Three of the sites should be along the eastern boundary of the landfill, and one site along the north boundary, one site at the northwest corner, and one site along the southwest boundary (Figure 6.1-1).

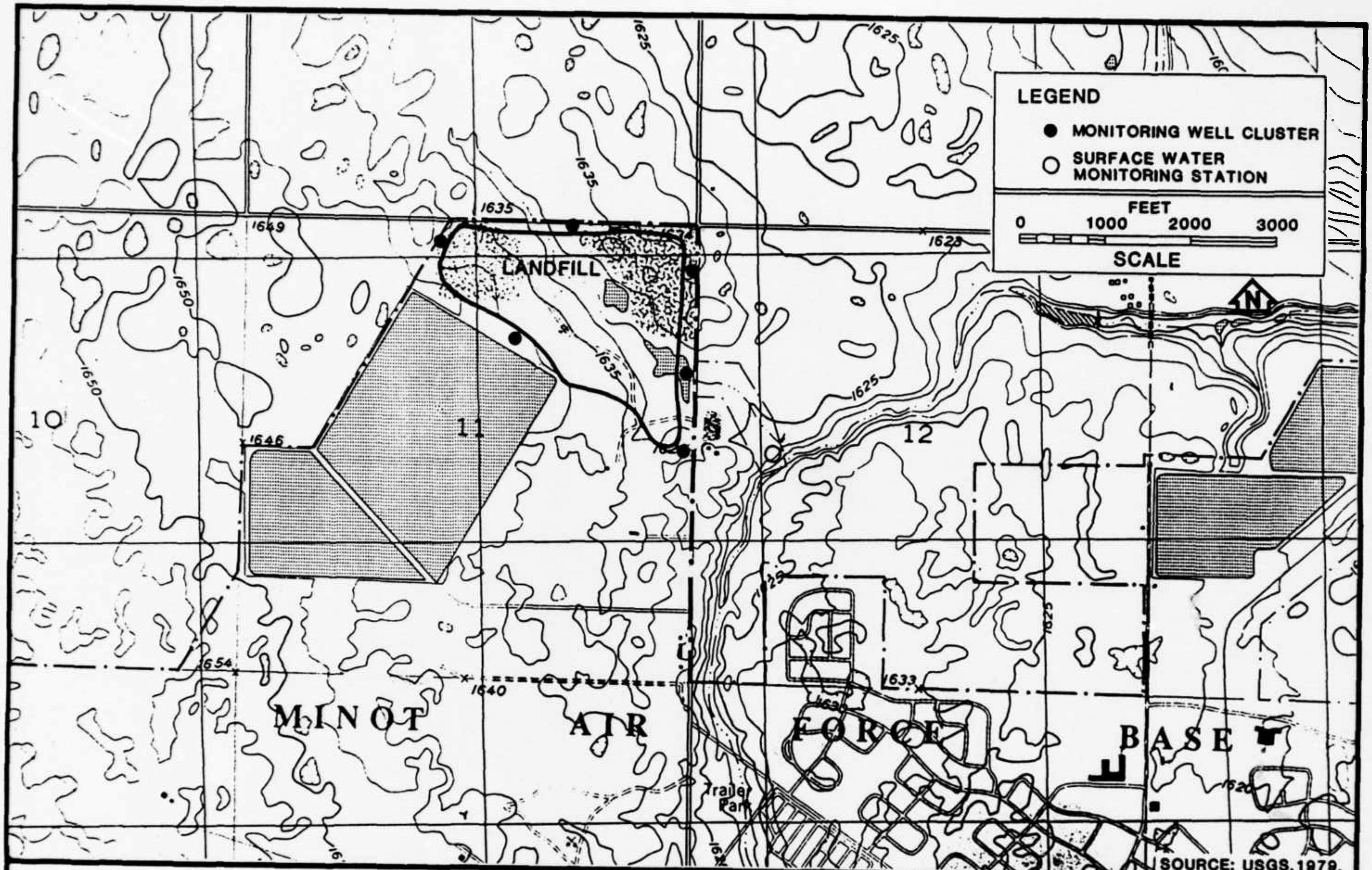

Figure 6.1-1
RECOMMENDED MONITORING LOCATIONS
FOR THE LANDFILL

INSTALLATION
RESTORATION PROGRAM
Minot Air Force Base

At each cluster a borehole should be drilled to bedrock first. Continuous core samples should be taken to the base of the first water-bearing unit and thereafter, one meter samples should be taken at major changes in stratigraphy. These core samples should be analyzed to determine hydrologic and attenuation properties. The four existing monitor wells should be surveyed horizontally and vertically, and water level measurements from these wells should be obtained concurrent with measurements in the new wells.

A surface water monitoring station should be established just upstream from the confluence of the two intermittant drainages (Figure 6.1-1). Flow should be measured monthly and water and sediment chemistry (all landfill parameters) samples taken quarterly. If significant periods exist where no flow occurs, samples should be taken in response to large precipitation events. A minimum of four samples per year should be required. If contamination is found, additional samples should be taken.

Table 6.1-1 summarizes the recommended monitoring for MAFB Phase II investigations.

6.2 LAND USE GUIDELINES

Careful consideration should be given to the uses made of the disposal areas for the following reasons:

1. To provide the continued protection of human health, welfare, and the environment;
2. To insure that the migration of potential contaminants is not promoted through improper land uses;
3. To facilitate the compatible development of future USAF facilities; and
4. To allow for identification of property which may be proposed for excess or outlease.

Table 6.1-1. Summary of Recommended Monitoring for MAFB Phase II Investigations.

Site	HARM Score	Recommended Sampling	Recommended Analysis
Landfill	61	Install six well clusters around the perimeter of the landfill (Figure 6.1-1). Sample soil to the base of the first permeable unit and thereafter at changes in lithology. Sample surface water and sediment downstream of landfill.	Total petroleum, hydrocarbon, halogenated and non-halogenated solvents metals, PCBs, and pesticides.
Firefighter Training Area	47	Install four well clusters at 90° from each other with respect to center of site (Figure 6.1-1). Sample the upper three feet of soil.	Total petroleum, hydrocarbons, halogenated solvents, metals, and PCBs.
EOD Area	36	Install four well clusters at 90° from each other with respect to the center of the site (Figure 6.1-1). Sample the upper three feet of soil.	Metals

Source, ESE, 1984.

In general, activities which would tend to disrupt the waste cells should be avoided so as not to facilitate contaminant migration. Such activities include foundation and drainage ditch construction. To avoid trapping any volatile compounds that may be released from the disposal areas, structures should not be placed over the sites.

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APPENDIX A

GLOSSARY OF TERMINOLOGY, ABBREVIATIONS AND ACRONYMS

APPENDIX A
GLOSSARY OF TERMINOLOGY, ABBREVIATIONS, AND ACRONYMS
(Page 1 of 5)

AD	Air Division
ADCOM	Aerospace Defense Command
AFB	Air Force Base
AFFF	Aqueous Film Forming Foam
AFS	Air Force Station
AG	Aboveground
AGE	Aerospace Ground Equipment
AMS	Avionics Maintenance Squadron
Aquiclude	Geologic unit which impedes ground water flow
Aquifer	A geologic formation, group of formations, or part of a formation capable of yielding water to a well or spring
ARRS	Aerospace Rescue and Recovery Squadron
BES	Bioenvironmental Engineering Section
BMW	Bombardment Wing
Cadmium	A metal used in batteries and other inudstrial applications; highly toxic to humans and aquatic life
Carbon tetrachloride	A solvent commonly in use until the 1960s; a suspected human carcinogen
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	Civil Engineering Squadron
cfs	Cubic feet per second
Chromium	A metal used in plating, cleaning, and other industrial applications; highly toxic to aquatic life at low concentrations, toxic to humans at higher levels

APPENDIX A
(Continued, Page 2 of 5)

Contaminated fuel	Fuel which does not meet specifications for recovery or recycle
Contamination	Degradation of natural water quality to the extent that its usefulness is impared; degree of permissible contamination depends on intended use of water
CSG	Combat Support Group
DEF	Fire Protection Branch
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DF	Diesel fuel
Disposal of hazardous waste	Discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment, be emitted into the air, or be discharged into any waters, including ground water
DOD	Department of Defense
Downgradient	In the direction of decreasing hydraulic static head; the direction in which ground water flows
DPDO	Defense Property Disposal Office
Effluent	Liquid waste discharged in its natural state or partially or completely treated from a manufacutring or treatment process
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
°F	Degrees Fahrenheit
FIS	Fighter Interceptor Squadron
FMMS	Field Missile Maintenance Squadron

FMS	Field Maintenance Squadron
FO	Fuel oil
ft	Feet
gal	Gallon
Ground water	Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure
HARM	Hazard Assessment Rating Methodology
Hazardous waste	As defined in RCRA, a solid waste or combination of solid wastes which become of its quantity, concentration, or physical, chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.
HQ	Headquarters
HRS	Hazard Ranking System
in	Inches
Infiltration	Movement of water through the soil surface into the ground
IRP	Installation Restoration Program
IR	Infrared
JP-4	Jet fuel used in T-37 and T-38 aircraft
Lead	A metal additive to gasoline and used in other industrial applications; toxic to humans and aquatic life; bioaccumulates
LCF	Launch Control Facility

Leachate	A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water
LF	Launch Facility
MAFB	Minot Air Force Base
MEK	methyl ethyl ketone, a solvent used in paint thinner, stripper, and a wide variety of industrial applications; suspected to be toxic to humans at high levels; potentially toxic to aquatic life
MMS	Munitions Maintenance Squadron
MOGAS	Motor gasoline
NDSHD	North Dakota State Department of Health
NWR	National Wildlife Refuge
OMS	Organizational Maintenance Squadron
PCB	Polychlorinated biphenyls, liquid used as a dielectric in electrical equipment; suspected human carcinogen; bioaccumulates in the food chain and causes toxicity to higher trophic levels
POL	Petroleum, oils, lubricants
ppm	Parts per million
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
SAC	Strategic Air Command
SMW	Strategic Missile Wing
SPF	Strategic Projection Force
Spill	An unplanned release or discharge of a hazardous waste onto or into air, land, or water

APPENDIX A
(Continued, Page 5 of 5)

SRAM	Short Range Attack Missile
TCE	Trichloroethylene, a commonly used degreasing solvent; toxic to aquatic life and a suspected human carcinogen
UG	Underground
Upgradient	In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of ground water
USAF	U.S. Air Force
USGS	U.S. Geological Survey
USSCS	U.S. Soil Conservation Service
Water table	Surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere
ybp	Years before present

APPENDIX B

TEAM MEMBER BIOGRAPHICAL DATA

JACKSON B. SOSEBEE, JR., M.S. *Professional Resume*

Areas of Specialization

Environmental Chemistry, Pollutant Fate Studies, Environmental Impact Analysis

Experience

Project Manager and Senior Chemist, Project Operations, ESE, Denver, Colorado, 1981 to present. Department Manager, Environmental Chemistry Department, ESE Gainesville, Florida 1974 to 1980.

Project Director, assessments of environmental fate and effects of potentially hazardous chemicals under Section 4 of TSCA for U.S. EPA.

Project Manager, environmental evaluation of proposed slow-speed diesel power generation sites to define scope of regulatory requirements and assess potential siting problems.

Project Manager, environmental survey of two U.S. Army depot activities in New Mexico (Ft. Wingate Depot Activity) and Arizona (Navajo Depot Activity) to determine levels of contaminants and potential for contaminant migration.

Project Manager, environmental licensing of two-unit coal-fired power plant in coastal zone of Florida. Program included identification of regulatory requirements, development of plan of study, and environmental studies.

Department Manager, responsible for supervision of 11 professional and technical laboratory personnel involved in environmental chemistry analyses and evaluation of data.

Project Manager, areawide water quality management study of the Tampa Bay Region. Study addressed water quality, socioeconomic, recreational, and ecological conditions.

Project Manager, water quality management study of Lake Sidney Lanier, Georgia, including water chemistry, plankton, and benthic macroinvertebrate measurements.

Project Manager, water quality study of Charlotte Harbor, Florida, and associated canals.

Project Manager, water quality and bioassay study of Black Warrior River below Cordove, Alabama, following spill of industrial wastewater.

Subproject Manager for numerous studies relating to water quality, pesticide and PCB analysis, wastewater characterization, and sediment chemistry.

Research Assistant, Chemistry Department, University of Montana, Missoula, Montana, 1974

Responsible for procedure development, field sampling, and analysis of phenolic compounds in the Clark Fork River.

Graduate Research, University of Montana, Missoula, Montana, 1971 to 1974

Conducted monitoring of carbon monoxide in the Missoula Valley, Montana.

Analysis and monitoring of flouride levels in the biota near Garrison, Montana.

Developed mathematical model of dissolved oxygen levels in the Clark Fork River; conducted field confirmation of model.

Mathematical modeling of atmospheric emissions originating from coal-fired power plants.

Graduate Teaching Assistant, Department of Chemistry, University of Montana, 1972 to 1974.

Education

M.S.	1974	Environmental Studies	University of Montana
B.S.	1969	Chemistry	Texas Tech University

Affiliations

American Chemical Society (ACS)

American Society for Testing and Materials (ASTM)--Biological Effects and Environmental Fate (Subcommittee Chairman)

Society for Environmental Toxicology and Chemistry

Publications and Presentations

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ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

DOUGLAS P. REAGAN, Ph.D.

Professional Resume

Areas of Specialization

Terrestrial Ecology, Wildlife Population Biology and Habitat Analysis, Endangered Species Studies, Environmental Impact Assessment

Experience

Senior Ecologist and Project Manager, ESE, Denver, Colorado, 1982 to Present.

Conducted terrestrial habitat analyses for dredge disposal sites on the upper Mississippi River.

Evaluated and designed ecological and land use portions of the Offsite Monitoring Program for Rocky Mountain Arsenal, Denver, Colorado.

Designed ecological monitoring program for EPA Superfund hazardous waste disposal site in Michigan.

Currently preparing environmental assessment for airport master plan in northern Utah.

Head, Terrestrial Ecology Division, Center for Energy and Environment Research, San Juan, Puerto Rico 1980 to 1982.

Principal Investigator, DOE sponsored Rain Forest Cycling and Transport Program. Coordinated program, managed field station, and conducted research on lizards and mannals in the Luquillo Mountains, Puerto Rico.

Principal Investigator, inventory of the Puerto Rican boa (endangered species) in the Caribbean National Forest, Puerto Rico.

Project Manager, baseline terrestrial ecology of coal/oil fired power plan sites in western Puerto Rico.

Scientist and Project Manager, NUS Corporation (1974 to 1976, Pittsburgh, Pennsylvania; 1976 to 1979, Denver Colorado)

Ecology Task Manager, regional siting study for radioactive waste disposal facility, Permian Basin (Colorado, Kansas, New Mexico, Oklahoma, Texas).

Project Manager, environmental impact assessment of well fields and pipelines, Maricopa County, Arizona.

Ecology Task Manager, environmental impact assessment of waste isolation pilot plant, southeastern New Mexico.

Wildlife Ecologist, environmental impact assessment for Senegal River Basin Development Project in Mali, Mauritania, and Senegal. Work included baseline studies, endangered species surveys, impact evaluation, and design of detailed mitigation plan for establishing two new national parks (including administrative infrastructure) in cooperation with the International Unions for the Conservation of Nature.

Project Manager, construction phase ecological monitoring at nuclear power plant site, Buckeye, Arizona.

Project Manager, environmental impact assessment of switching station sites in southern California.

Ecology Task Manager, environmental impact assessment for uranium mill in southwestern Colorado.

Ecology Task Manager, environmental impact assessment and black-footed ferret survey of underground trona mine in southwestern Wyoming.

Wildlife Ecologist, environmental impact assessment for nuclear power plants at sites in southern California, southern Texas, northern Ohio, Wisconsin, and New York.

Wildlife Ecologist, environmental impact assessment for three underground coal mines, Price Utah.

Wildlife Ecologist, environmental impact assessment for surface coal mine in southwestern Wyoming.

Wildlife Ecologist for evaluation of system concept and deployment of MX missle in Arizona, Nevada, New Mexico, and Texas.

Wildlife Ecologist, regional siting study for nuclear power plants, Washington and Oregon.

Wildlife Ecologist, *in situ* uranium mine feasibility study, central Wyoming.

Wildlife Ecologist, environmental impact assessment for three underground borax mine sites, Death Valley, California.

Wildlife Ecologist, feasibility study for surface coal mine site, southwestern Wyoming.

Wildlife Ecologist, environmental baseline studies for oil shale development, northwestern Colorado.

Wildlife Ecologist, right-of-way surveys for transmission line corridors (340 mi.) in southern California.

Principal Investigator, survey and determination of threatened and endangered species of amphibians and reptiles in Arkansas.

Education

Ph.D.	Zoology (Ecology)	1972	University of Arkansas
M.S.	Biology	1967	University of New Mexico
B.A.	Biology	1964	Hartwick College, New York

Affiliations

Adjunct Scientist - Center for Energy and Environment Research, San Juan, Puerto Rico.

Research Coordinator - Wright-Ingraham Institute, Colorado Springs, Colorado.

Castle Rock Planning Commission, Castle Rock, Colorado.

American Society of Ichthyologists and Herpetologists

Ecological Society of America

Sigma Xi

Publications

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Papers in Preparation

Reagan, D. P., R. W. Garrison, and R. B. Waide. Food web relationship and animal community organization in an insular tropical rain forest.

Reagan, D. P. (with R. W. Garrison). Good resource partitioning in Puerto Rican rain forest anoles.

Reagan, D. P. Invertebrate predation and food loops in the food web of a Puerto Rican rain forest.

Reagan, D. P. Courtship behavior of the giant anole, Anolis cuvieri.

Reagan, D. P., J. C. Gillingham, and D. Clark. Cross predation among Puerto Rican anoles (Anolis supp.).

Reagan, D. P. Nest construction by Anolis stratulus in tabonuco rain forest on Puerto Rico.

Reagan, D. P. Chapter on reptiles and synthesis chapter for book on food web organzation in a tropical rain forest.

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

DOUGLAS A. DEAN *Professional Resume*

Areas of Specialization

Environmental Engineering, Water and Waste Treatment Processes, Pulp and Paper Technology, and Treatability Studies

Experience

Environmental Engineer, Water/Waste Treatment Department, ESE, Gainesville, Florida, July 1983 to present.

Air Force Records Search, Project Engineer--Assessment of current and past handling and disposal practices for toxic/hazardous materials on U.S. Air Force installations. Includes an evaluation of the potential for offiste migration of toxic materials.

Martin Electronics Treatment Plant Operating Permit, Subproject Manager--Tasks included the development of all permitting data, evaluating the facility for compliance with state regulations, and serving as a liaison between client and the state regulatory agency.

Pratt Whitney Water Treatment Plant Evaluation, Project Engineer--Conducted bench-scale testing to determine optimum treatment process for THM precursor removal. Short-term chlorination was examined with respect to free chlorine demand, THM formation potential, and color removal.

Miami Beach Public Notification Report, Project Engineer--Responsible for developing a public notification and remedial action strategy to be used during water contamination incidents.

Power Company Hazardous Waste Inventories, Project Engineer--Responsibilities included onsite investigations of current waste generation and disposal practices occurring at power plants and operation facilities, and evaluation of the potential liabilities to the company as a result of these wastes.

Tampa Electric Company, Project Engineer--Responsible for conducting bench-scale coagulation/settling tests to evaluate the removal of iron from the slag pond at Tampa Electric's Big Bend station. Activities included jar test screening and optimization of various combinations of coagulants and polymers, settling column testing, an assessment of feasibility of various alternatives for treatment, and recommendation of the preferred treatment alternative.

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Okeechobee Water Works, Okeechobee, Florida, Project Engineer--Conducted a THM process control study for the 2.8 MGD combined coagulation/softening plant. Tasks involved reviewing existing plant records for existing process evaluation and potential for upgrade, jar testing to determine optimum coagulation for the removal of color, and THM sampling and analyses. THM control alternatives most likely to meet regulatory requirements were identified and evaluated.

Bonita Springs Water Utility, Bonita Springs, Florida, Project Engineer--Participated in a municipal water plant upgrading study. Responsibilities included the performance of jar test to determine optimum softening conditions, and the collection of THM samples throughout plant.

U.S. EPA Effluent Limitations Guidelines for the Pesticide Industry, Project Engineer--Responsible for developing the technical support used to establish U.S. EPA's effluent guidelines for the pesticide industry. Evaluated industry comments and data and incorporated new information into the data base. Analyzed treatment and treatability information pertinent to the industry for the purpose of determining plant-specific pollutant concentrations deemed achievable for each pesticide manufactured.

V.A. Medical Center, Gainesville, Florida, September through December 1982, Research Associate--Responsibilities included preparing medication and electrolyte-free diets for animals involved in a metabolic research study. Instructed four full-time hospital technicians in the proper care and handling of laboratory facilities and specimens.

University of Florida Engineering Department, Gainesville, Florida, May through September 1982, Research Coordinator--Conducted a literature search and review of Florida's phosphate industry. Examined the various environmental problems and treatment technologies common to the industry, especially in regards to clay slimes. Designed a one-credit course outline using the information gathered from the review. Activities included extensive computer work on a program used in the supervisor's graduate level class.

Georgia-Pacific Corporation, Palatka, Florida, September through December 1980, Environmetnal Technician--Environmental activities included air stack monitoring of the lime kiln and recovery boiler, daily sampling and measurement of flow and conventional pollutants in the oxidation ponds, and recording data

D-MRAF.1/DAD
09/12/84

into the monthly records. Measured oxygen content of empty vessels prior to maintenance to determine if hazardous vapors are present. Quality control task included sampling and analyses for soluble sulfides in lime mud and washwaters, and bench-scale research on the optimization of tall oil yields.

St. Regis Paper Company, Cantonment, Florida, May through August 1979, Student Technician--Assisted chemical engineers on a pilot study of the conversion of black liquor to a char with a high heating value. Project elements included collecting and filtering samples taken during pilot runs, and recording thermocouple readings to calculate heat losses across the tubular reactor. Wrote a report estimating the specific heat of black liquor at critical temperatures and pressures.

Education

B.S.	1982	Environmental Engineering	University of Florida

Affiliations

American Water Works Association

Honors

Received Presidential Recognition Certificate for Outstanding Contribution from Florida, May 1982.

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09/12/84

APPENDIX C

LIST OF INTERVIEWEES
LIST OF OUTSIDE CONTACTS

APPENDIX C
LIST OF INTERVIEWEES
(Page 1 of 3)

Position	Years of Service
FMMS	
Check Sergeant, Refrigeration and Electric	1
Shop Branch NCOIC	3
Acting NCOIC, C. Control	1
NCOIC, Mechanic Shop	9
NCOIC, Pneudraulics	9
NCIOC, Engineering Control Branch	12
OIC, FMMS Branch	1
Maintenance Team Member	1
Maintenance Team Member	10
NCOIC of Accounting	6
Other	
Environmental Coordinator	10
NCOIC, BES	7
NCOIC, Sheet Metal Shop	3
Assistant NCOIC, Sheet Metal Shop	1
NCOIC, Machine Shop	1
NCOIC, Electrical Shop	3
Marketing Specialist	15
Retired Civilian, DPDO	14
Assistant NCOIC, Corrosion Control	10
Wheel and Tire Shop	3
NCOIC, Egress	1
Assistant NCOIC, Repair/Reclamation	5
Assistant NCOIC, AGE	1
Liquid Fuels	12
Civilian, Liquid Fuels	25
Civilian, CES	15
Civilian, Paint Shop	19
Civilian, Exterior Electric	15
Chief, Weather Station Operations	15
Public Affairs	15
Chief Realty Officer, Real Property	10
Missile Engineer	15
Technician, Bio-environmental Engineering	5
Airfield Clearing Equipment Foreman	15
Bismarck Maintenance Supervisor	6
OIC, Hospital Laboratory	1
NCOIC, Fuels Laboratory	4
NCOIC, Conventional Munitions Maintenance	2
Pest Controller	16
Fire Chief	18
Civilian Caretaker (Fortuna)	10
Civilian Caretaker (Fortuna)	10

APPENDIX C
LIST OF OUTSIDE CONTACTS
(Page 2 of 3)

Neil M. Knatterud, Manager
Waste Management Program
North Dakota State Department of Health
Bismarck, North Dakota 58505
701-224-2366

Water Resources Division
U. S. Geological Survey
Bismarck, North Dakota 58501
701-255-4011

Milton Lindvic, Director
Hydrology Division
North Dakota State Water Commission
Bismarck, North Dakota
701-224-2754

Bruce Schmidt, Agricultural Agent
Ward County Cooperative Extension Service
Minot, North Dakota
701-857-6444

U. S. Geological Survey Library
Denver, Colorado
303-234-4133

Arthur Lakes Library
Colorado School of Mines
Golden, Colorado 80401
303-273-3680

Maurice Wright, Refuge Officer
Upper Souris National Wildlife Refuge
Foxholm, North Dakota 58738
701-468-5467

Greg Nelson, Planning Commission Secretary
Ward County Auditor's Office
Minot, North Dakota
701-852-4437

Mike McKenna, Game Biologist
North Dakota Game and Fish Department
Bismarck, North Dakota
701-224-4877

APPENDIX C
LIST OF OUTSIDE CONTACTS
(Page 3 of 3)

North Dakota Geological Survey
University of North Dakota
Grand Forks, North Dakota

Albert Simpson Historical Research Center
Maxwell AFB, Alabama

National Archives and Records Service
Modern Military Branch
Washington, D.C.

National Archives and Records Service
Cartographic and Architectural Branch
Alexandria, Virginia

Washington National Records Center
Suitland, Maryland

U.S. Air Force History Office
Bolling AFB
Washington, D.C.

APPENDIX D

MASTER LIST OF SHOPS

APPENDIX D
MASTER LIST OF SHOPS
(Page 1 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste
91st STRATEGIC MISSILE WING			
91st Field Missile Maintenance Squadron			
Power - Electric	546	Yes	Yes
Mechanical Shop	546	Yes	Yes
Electronics Lab	546	No	No
Periodic Maintenance Teams	546	No	No
Corrosion Control	546	Yes	Yes
Pneudraulics	546	Yes	Yes
Vehicle Equipment Control	546	No	No
91st Supply Squadron			
Fuels Control Center	420	No	No
91st Transportation Squadron			
Heavy Equipment	425	Yes	Yes
General Purpose I	425	Yes	Yes
General Purpose II	426	Yes	Yes
Refueling Maintenance	457	Yes	Yes
Diagnostic/QC	460	Yes	Yes
5th BOMB WING			
Field Maintenance Squadron			

APPENDIX D
MASTER LIST OF SHOPS
(Continued, Page 2 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste
AGE Branch	995	Yes	Yes
Egress	Dock 3	Yes	No
Repair and Reclamation	857	Yes	Yes
Wheel/Tire Shop	Dock 3	Yes	Yes
Electric Shop	857	Yes	Yes
Environmental Systems	857	No	No
Fuel Systems	836	Yes	No
Hydraulics	857	Yes	Yes
Corrosion Control	837	Yes	Yes
Machine Shop	837	No	No
NDI	857	Yes	Yes
Survival Equipment	893	Yes	No
Structural Repair	857	Yes	No
Welding Shop	857	No	No
Jet Engine Repair	756	Yes	Yes
Test Cell	973	Yes	No
Survival Equipment	893	Yes	No
Avionics Maintenance Squadron			
Electronic CM	859	Yes	No
Radar/Dopper	859	Yes	No
Radio Shop	859	Yes	No
Instrument Shop	859	No	No

APPENDIX D
MASTER LIST OF SHOPS
(Continued, Page 3 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste
Flight Control	859	Yes	No
PMEL	475	Yes	No
Photo Shop	859	Yes	No
Fire Control Shop	859	No	No
Munitions Maintenance Squadron			
Equipment Maintenance Branch	1113	Yes	Yes
Munitions Services Branch	975	Yes	Yes
Conventional Munitions	1118	Yes	No
Air Launch Missile Maintenance	1113	Yes	No
Mark-12	1119	Yes	No
Organization Maintenance Squadron			
Alert Branch	1085	No	No
Bomber Branch	867	Yes	Yes
Tanker Branch	862	No	No
Phase Inspection	867	Yes	Yes
91st Combat Support Group Civil Engineering Squadron			
Sheet Metal Shop	445	No	No
Fire Department	897	Yes	No

APPENDIX D
MASTER LIST OF SHOPS
(Continued, Page 4 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste
Interior Electric	430	No	No
Exterior Electric	470	Yes	Yes
Pavement/Grounds	521	Yes	No
Environmental Support	994	Yes	Yes
Heat Shop	445	No	No
Liquid Fuels	445	No	No
Corrosion Control	445	Yes	No
SMART Shop	470	No	No
Refrigeration	445	No	No
Plumbing	445	No	No
Entomology	445	Yes	No
Structural Repair	445	No	No
91st Services Squadron			
BX Gas Station	585	No	No
Firing Range	20188	Yes	Yes
5th Fighter Interceptor Squadron			
Integrated Avionics	774	No	No
Life Support	768	Yes	No
Avionics Flightline	758	No	No
Corrosion Control	763	Yes	Yes
Egress	763	No	No

APPENDIX D
MASTER LIST OF SHOPS
(Continued, Page 5 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste
Electric Shop	729	Yes	No
Specialist Flight	758	Yes	No
Pneudraulics	766	Yes	Yes
Structural Repair	763	Yes	No
T-33 Aircraft Repair	758	Yes	No
Weapons Load	766	Yes	Yes
Air Crew Training	767	No	No
Air Maintenance	1107	No	No
Missile Maintenance	879	Yes	No
Survival Repair	893	Yes	No
Inspection Section	763	Yes	Yes
Jet Engine Shop	748	Yes	No
Alert	718	Yes	No
9th Weather Squadron, Det. 21		No	No
2150th Communications Squadron			
Base Radio Maintenance	392	No	No
Crypto Maintenace	121	Yes	No
Hardened Cable	523	Yes	No
Radar Maintenance	999	No	No
NAVAIDS Maintenance	523	Yes	No
Weather Maintenance	746	No	No
SACCS Maintenance	523	No	No

APPENDIX D
MASTER LIST OF SHOPS
(Continued, Page 6 of 6)

Facility/Shop	Location	Handles Hazardous Materials	Produces Hazardous Waste
Missile Control	523	No	No
RAPCON	999	No	No
Hardened Antenna	523	Yes	No
USAF Hospital			
Hospital Maintenance	H-1	No	No
Heat Plant	H-6	No	No
Dental Clinic	165	Yes	No
Medical X-ray	H-1	No	No
Medical Supply	H-6	No	No
Laboratory	H-1	Yes	No

APPENDIX E

USAF IRP HAZARD ASSESSMENT RATING METHODOLOGY

USAF INSTALLATION RESTORATION PROGRAM

HAZARD ASSESSMENT RATING METHODOLOGY

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

> "develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the Records Search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from USAF Occupational Environmental Health Laboratory (OEHL), Air Force Engineering Services Center (AFESC), Engineering-Science (ES) and CH_2M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for 6 months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF OEHL, AFESC, various major commands, Engineering Science, and CH_2M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of IRP.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data readily obtained during the Record Search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: the possible receptors of the contamination, the waste and its characteristics, potential pathways for waste contaminant migration, and any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating.

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and ground-water migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste managment practices category factor to the sum of the scores for the other three categories.

HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART

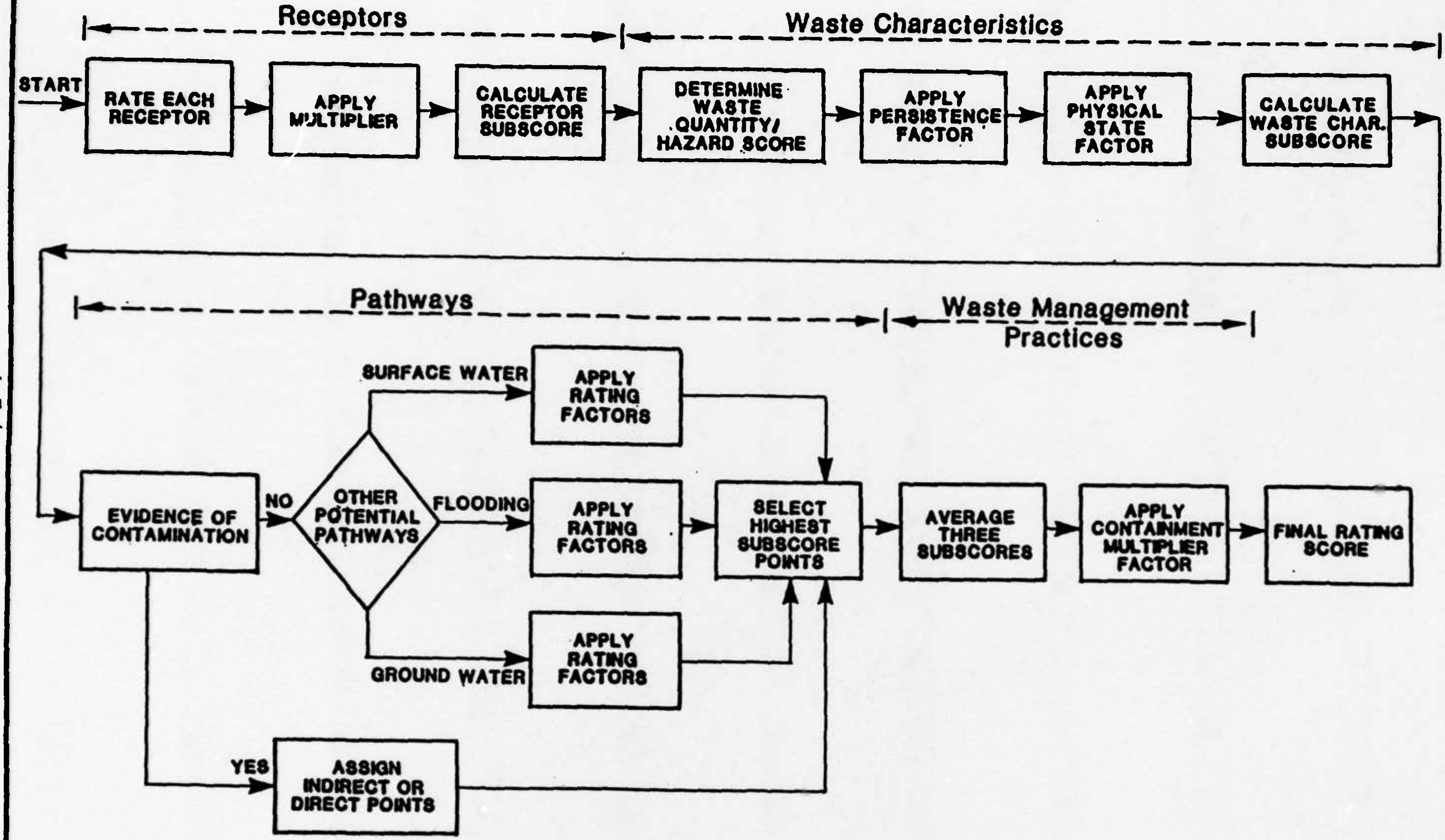


FIGURE 2

HAZARD ASSESSMENT RATING METHODOLOGY FORM

NAME OF SITE ______________________________

LOCATION ______________________________

DATE OF OPERATION OR OCCURRENCE ______________________________

OWNER/OPERATOR ______________________________

COMMENTS/DESCRIPTION ______________________________

SITE RATED BY ______________________________

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		
B. Distance to nearest well		10		
C. Land use/zoning within 1 mile radius		3		
D. Distance to reservation boundary		6		
E. Critical environments within 1 mile radius of site		10		
F. Water quality of nearest surface water body		6		
G. Ground water use of uppermost aquifer		9		
H. Population served by surface water supply within 3 miles downstream of site		6		
I. Population served by ground-water supply within 3 miles of site		6		
Subtotals			______	______

Receptors subscore (100 X factor score subtotal/maximum score subtotal) ______

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) ______
2. Confidence level (C = confirmed, S = suspected) ______
3. Hazard rating (H = high, M = medium, L = low) ______

Factor Subscore A (from 20 to 100 based on factor score matrix) ______

B. Apply persistence factor
Factor Subscore A X Persistence Factor = Subscore B

______ X ______ = ______

C. Apply physical state multiplier

Subscore B X Physical State Multiplier = Waste Characteristics Subscore

______ X ______ = ______

FIGURE 2 (Continued)

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore ______

B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and ground-water migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water		8		
Net precipitation		6		
Surface erosion		8		
Surface permeability		6		
Rainfall intensity		8		
Subtotals			______	______

Subscore (100 X factor score subtotal/maximum score subtotal) ______

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding		1		

Subscore (100 x factor score/3) ______

3. Ground-water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to ground water		8		
Net precipitation		6		
Soil permeability		8		
Subsurface flows		8		
Direct access to ground water		8		
Subtotals			______	______

Subscore (100 x factor score subtotal/maximum score subtotal) ______

C. Highest pathway subscore.

Enter the highest subscore value from A, B-1, B-2 or B-3 above.

Pathways Subscore ______

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors ______
Waste Characteristics ______
Pathways ______

Total ______ divided by 3 = ______
Gross Total Score

B. Apply factor for waste containment from waste management practices

Gross Total Score X Waste Management Practices Factor = Final Score

______ X ______ = ☐

TABLE 1

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

I. RECEPTORS CATEGORY

Rating Factors	Rating Scale Levels 0	1	2	3	Multiplier
A. Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land Use/Zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or industrial	Residential	3
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E. Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination.	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands.	10
F. Water quality/use designation of nearest surface water body	Agricultural or industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies	6
G. Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, municipal water available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1, 000	6

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

S = Small quantity (<5 tons or 20 drums of liquid)
M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
L = Large quantity (>20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- o Verbal reports from interviewer (at least 2) or written information from the records.
- o Knowledge of types and quantities of wastes generated by shops and other areas on base.
- o Based on the above, a determination of the types and quantities of waste disposed of at the site.

S = Suspected confidence level

- o No verbal reports or conflicting verbal reports and no written information from the records.
- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site.

A-3 Hazard Rating

Hazard Category	Rating Scale Levels: 0	1	2	3
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2	Sax's Level 3
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F	Flash point less than 80°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels	Over 5 times background levels

Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	M
	M	C	H
70	L	S	H
60	S	C	H
	M	C	M
50	L	S	M
	L	C	L
	M	S	H
	S	C	M
40	S	S	H
	M	S	M
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	M
20	S	S	L

Notes:
For a site with more than one hazardous waste, the waste quantities may be added using the following rules:
Confidence Level
- o Confirmed confidence levels (C) can be added
- o Suspected confidence levels (S) can be added
- o Confirmed confidence levels cannot be added with suspected confidence levels

Waste Hazard Rating
- o Wastes with the same hazard rating can be added
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCM + SCH = LCM if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCM designation (60 points). By adding the quantities of each waste, the designation may change to LCM (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Persistence Criteria	Multiply Point Rating From Part A by the Following
Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Physical State	Multiply Point Total From Parts A and B by the Following
Liquid	1.0
Sludge	0.75
Solid	0.50

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 POTENTIAL FOR SURFACE WATER CONTAMINATION

Rating Factor	Rating Scale Levels: 0	1	2	3	Multiplier
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet	8
Net precipitation	Less than -10 in.	-10 to + 5 in.	+5 to +20 in.	Greater than +20 in.	6
Surface erosion	None	Slight	Moderate	Severe	8
Surface permeability	0% to 15% clay ($>10^{-2}$ cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	Greater than 50% clay ($<10^{-6}$ cm/sec)	6
Rainfall intensity based on 1 year 24-hr rainfall	<1.0 inch	1.0-2.0 inches	2.1-3.0 inches	>3.0 inches	8

B-2 POTENTIAL FOR FLOODING

Rating Factor	0	1	2	3	Multiplier
Floodplain	Beyond 100-year floodplain	In 25-year floodplain	In 10-year floodplain	Floods annually	1

B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION

Rating Factor	0	1	2	3	Multiplier
Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.	6
Soil permeability	Greater than 50% clay ($>10^{-6}$ cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	0% to 15% clay ($<10^{-2}$ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean ground-water level	8
Direct access to ground water (through faults, fractures, faulty well casings, subsidence fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	8

TABLE 1 (Continued)

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. WASTE MANAGEMENT PRACTICES FACTOR

The following multipliers are then applied to the total risk points (from A):

Waste Management Practice	Multiplier
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Fire Proection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III-B-3, then leave blank for calculation of factor score and maximum possible score.

APPENDIX F

HAZARD ASSESSMENT RATING METHODOLOGY FORMS

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: EOD Area

Location: SW Quarter of Section 11, NW Quarter of Section 14, T157N R83W

Date of Operation or Occurrence: 1960 to Present

Owner/Operator: USAF - MAFB

Comments/Description: Residues from Detonated Explosives

Site Rated By: J.B. Sosebee and D.P. Reagan

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	1	10	10	30
C. Land use/zoning within 1-mile radius	1	3	3	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1-mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground water supply within 3 miles of site	1	6	6	18
SUBTOTALS			75	180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				42

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) 5
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) L

Factor Subscore A (from 20 to 100 based on factor score matrix) 30

B. Apply persistence factor:
Factor Subscore A x Persistence Factor = Subscore B
30 x 1.0 = 30

C. Apply physical state multiplier:
Subscore B x Physical State Multiplier = Waste Characteristics Subscore
30 x 0.5 = 15

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore ____

B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	0	8	0	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
SUBTOTALS			46	108
Subscore (100 x factor score subtotal/maximum score subtotal)				43
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground water migration				
Depth to ground water	2	8	16	24
Net precipitation	3	6	18	18
Soil permeability	1	8	8	24
Subsurface flows	2	8	16	24
Direct access to ground water	1	8	8	24
SUBTOTALS			66	114
Subscore (100 x factor score subtotal/maximum score subtotal)				58

C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 58

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	42
Waste Characteristics	15
Pathways	58
TOTAL	115 divided by 3 = 38 Gross total score

B. Apply factor for waste containment from waste management practices.
Gross total score x waste management practices factor = final score.

38 x 1.0 = 38

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Firefighter Training Area

Location: SW Quarter of Section 14, R157N T83W

Date of Operation or Occurrence: Mid-1960s to Present

Owner/Operator: USAF - MAFB

Comments/Description: Mostly JP-4 fuel with some oil and grease

Site Rated By: J.B. Sosebee and D.P. Reagan

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	1	10	10	30
C. Land use/zoning within 1-mile radius	1	3	3	9
D. Distance to reservation boundary	2	6	12	18
E. Critical environments within 1-mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground water supply within 3 miles of site	1	6	6	18
SUBTOTALS			75	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 42

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) M
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) M

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor:
Factor Subscore A x Persistence Factor = Subscore B
60 x 0.8 = 48

C. Apply physical state multiplier:
Subscore B x Physical State Multiplier = Waste Characteristics Subscore
48 x 1.0 = 48

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore --

B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	0	8	0	24
Net precipitation	3	6	18	18
Surface erosion	1	8	8	24
Surface permeability	2	6	12	18
Rainfall intensity	1	8	8	24
SUBTOTALS			46	108
Subscore (100 x factor score subtotal/maximum score subtotal)				43
2. Flooding	0	1	0	3
Subscore (100 x factor score/3)				0
3. Ground water migration				
Depth to ground water	2	[illegible]	16	24
Net precipitation	3	6	18	18
Soil permeability	1	8	8	24
Subsurface flows	2	8	16	24
Direct access to ground water	1	8	8	24
SUBTOTALS			66	114
Subscore (100 x factor score subtotal/maximum score subtotal)				58

C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 58

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	42
Waste Characteristics	48
Pathways	58
TOTAL	148 divided by 3 = 49 Gross total score

B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

49 x 0.95 = 47

HAZARD ASSESSMENT RATING METHODOLOGY FORM

Name of Site: Sanitary Landfill

Location: Northeast Quarter of Section 12, T157N R83W

Date of Operation or Occurrence: 1957 to Present

Owner/Operator: USAF - MAFB

Comments/Description: Sanitary Landfill with some industrial and hazardous waste

Site Rated By: J.B. Sosebee and D.P. Reagan

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site	0	4	0	12
B. Distance to nearest well	1	10	10	30
C. Land use/zoning within 1-mile radius	1	3	3	9
D. Distance to reservation boundary	3	6	18	18
E. Critical environments within 1-mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	1	6	6	18
G. Ground water use of uppermost aquifer	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	0	6	0	18
I. Population served by ground water supply within 3 miles of site	1	6	6	18
SUBTOTALS			81	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 45

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (1=small, 2=medium, 3=large) L
2. Confidence level (1=confirmed, 2=suspected) C
3. Hazard rating (1=low, 2=medium, 3=high) M

Factor Subscore A (from 20 to 100 based on factor score matrix) 80

B. Apply persistence factor:
Factor Subscore A x Persistence Factor = Subscore B
80 x 0.8 = 64

C. Apply physical state multiplier:
Subscore B x Physical State Multiplier = Waste Characteristics Subscore
64 x 0.75 = 48

HAZARD ASSESSMENT RATING METHODOLOGY FORM
(Continued, Page 2 of 2)

III. PATHWAYS

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 100

B. Rate the migration potential for three potential pathways: surface water migration, flooding, and ground water migration. Select the highest rating and proceed to C.

Rating Factor	Factor Rating (0-3)	Multi-plier	Factor Score	Maximum Possible Score
1. Surface water migration				
Distance to nearest surface water	___	8	___	24
Net precipitation	___	6	___	18
Surface erosion	___	8	___	24
Surface permeability	___	6	___	18
Rainfall intensity	___	8	___	24
SUBTOTALS			___	108
Subscore (100 x factor score subtotal/maximum score subtotal)				___
2. Flooding	___	1	___	3
Subscore (100 x factor score/3)				___
3. Ground water migration				
Depth to ground water	___	8	___	24
Net precipitation	___	6	___	18
Soil permeability	___	8	___	24
Subsurface flows	___	8	___	24
Direct access to ground water	___	8	___	24
SUBTOTALS			___	114
Subscore (100 x factor score subtotal/maximum score subtotal)				___

C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3 above.

Pathways Subscore 100

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors 45

Waste Characteristics 48

Pathways 100

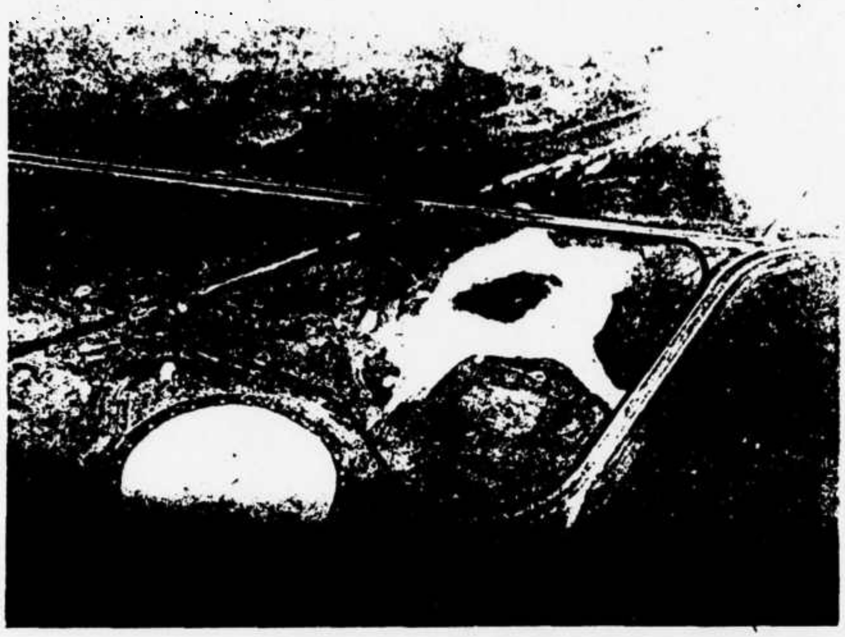
TOTAL 193 divided by 3 = 64 Gross total score

B. Apply factor for waste containment from waste management practices. Gross total score x waste management practices factor = final score.

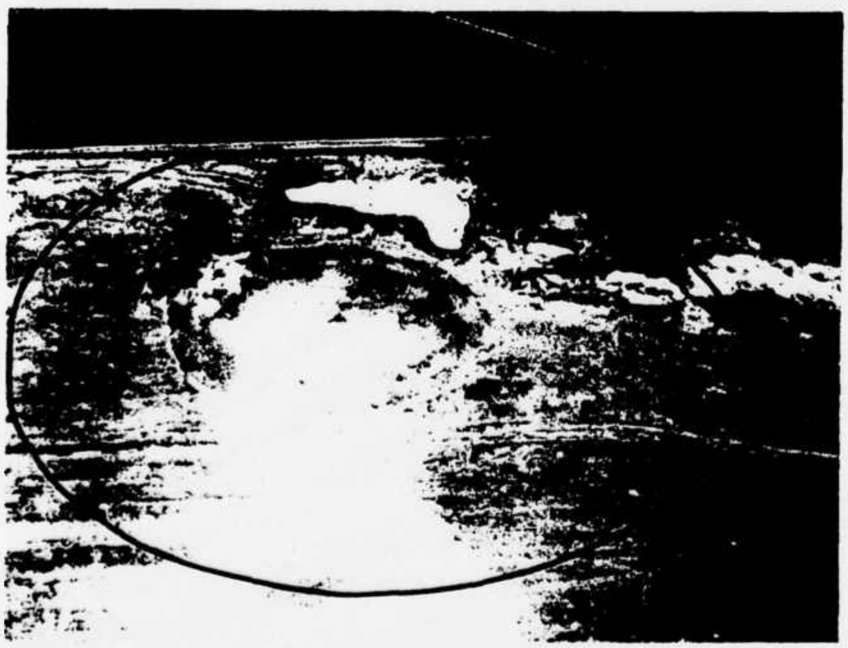
64 x 0.95 = 61

APPENDIX G

PHOTOGRAPHS OF DISPOSAL/SPILL SITES



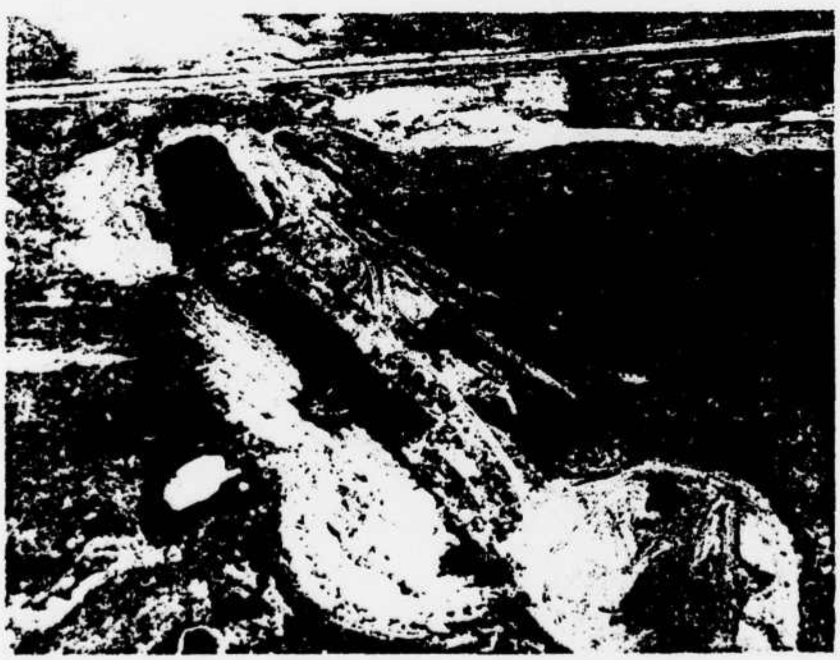
FIREFIGHTER TRAINING AREA (LOOKING NORTH)



EOD AREA (LOOKING NORTH)

AREAS OF POTENTIAL CONTAMINATION	INSTALLATION RESTORATION PROGRAM Minot Air Force Base

SANITARY LANDFILL (LOOKING WEST)



OPEN PITS WITHIN THE THE SANITARY LANDFILL
(LOOKING NORTH)

AREAS OF POTENTIAL CONTAMINATION	INSTALLATION RESTORATION PROGRAM Minot Air Force Base

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